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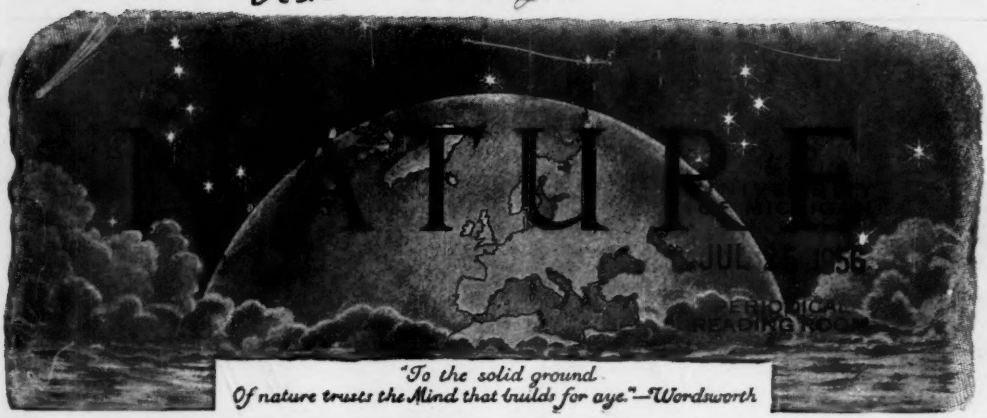

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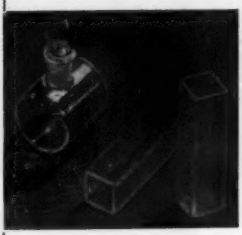

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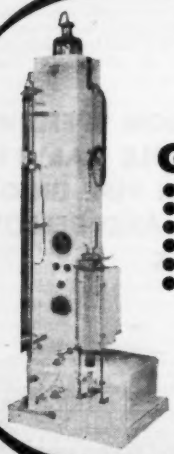

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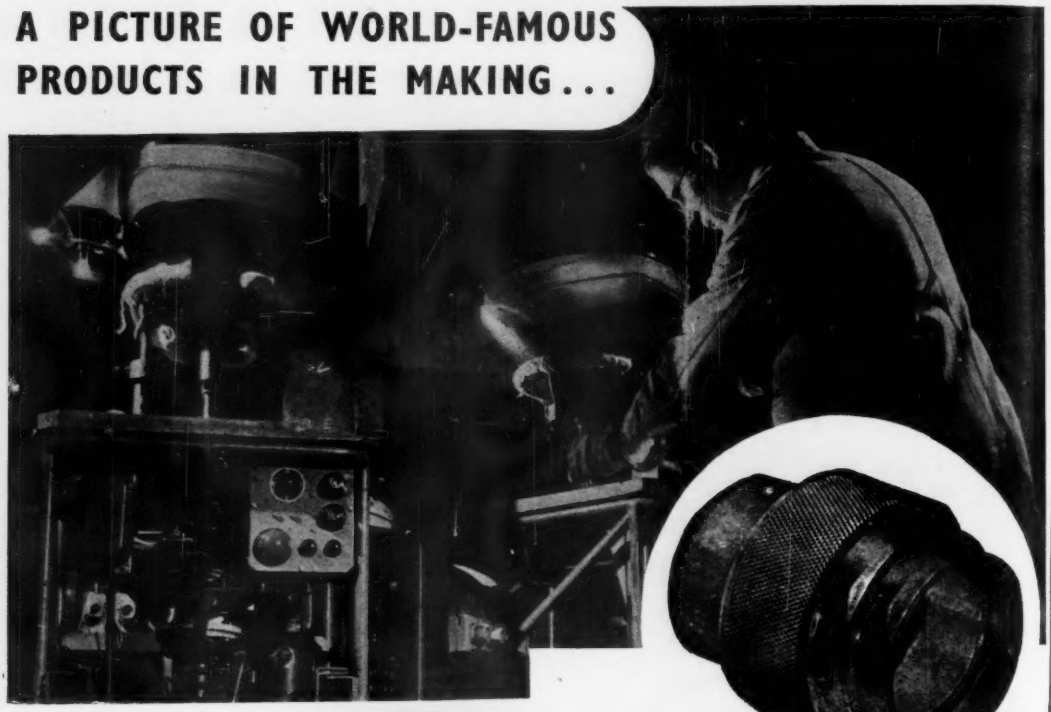

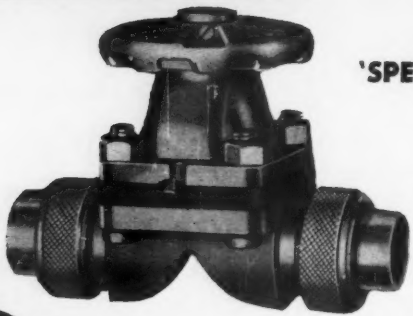

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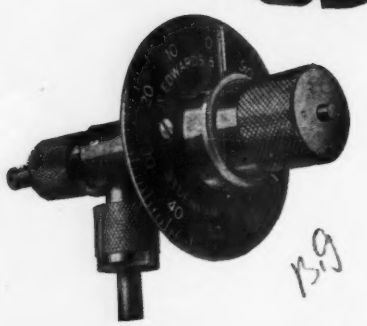

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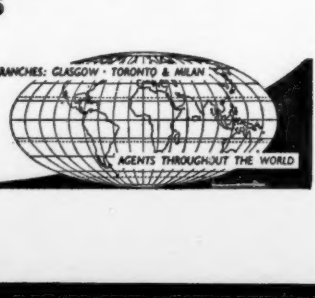

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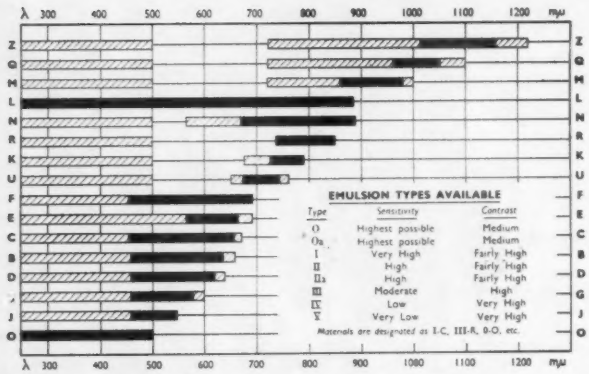

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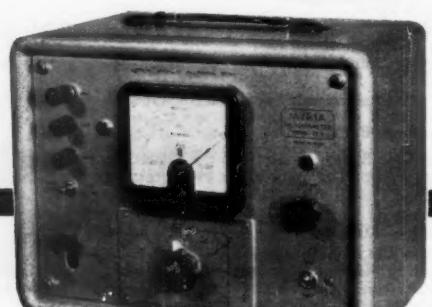

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"IT shall be the duty of every local education authority to secure that there shall be available for their area sufficient schools . . . for providing secondary education, that is to say, full-time education suitable to the requirements of senior pupils . . . and the schools available for an area shall not be deemed to be sufficient unless they are sufficient in number, character and equipment to afford for all pupils opportunities for education offering such variety of instruction and training as may be desirable in view of their different ages, abilities and aptitudes . . ."

Twelve years after these high hopes were incorporated as Section 8 of the Education Act, 1944, P.E.P. has investigated the position of those schools the duty of which it is to provide secondary education for scholars who have been unsuccessful in obtaining places in grammar or technical schools*. From the start, the Ministry of Education has shown that its intentions towards the secondary modern school have always been honourable. In one of its explanatory pamphlets, for example†, it was stated that "secondary education is to be the right of all and no longer the privilege of the few". The promise implied that all schools for children over the age of eleven were to have "the advantages and amenities hitherto exclusively associated with the limited number of schools called secondary schools up to 1944". Each school was to have a properly equipped gymnasium with changing rooms and shower baths, a library, an art and crafts room, rooms for practical activities, a dining room, a playground and playing fields. The regulations governing the number and size of classrooms were to be applied to all secondary schools. There was to be a common maximum of thirty pupils in a class, and no differentiation between the various types of schools so far as teachers' qualifications and salaries were concerned.

In some ways the promise of secondary education for all in the 1944 Act can be regarded as a continuation of the British educational system's time-honoured process of making *ad hoc* provision for pupils who had no chance of sharing in the limited amount of secondary education provided. In the early part of this century this had been shown in the development of higher elementary, central and junior technical schools. In the Hadow Report of 1926 it was recommended that all children after spending the first years of their school lives in a primary or elementary school should spend the last three or four years in a "well equipped and well staffed modern school (or senior department) under the stimulus of practical work and realistic studies, and yet, at the same time, in the free and broad air of a general humane education". The 1944 tripartite division of secondary education into grammar, technical and modern followed naturally from earlier experiments and developments.

* Secondary Modern Schools. (P.E.P.) 2*s*. 6*d*.
† Pamphlet 9. The New Secondary Education. (H.M.S.O., 1947.)

The Ministry has always made it clear that the modern school was to be no pale imitation of the grammar school, and assumed that not all the most intelligent children would wish to go to grammar schools. Throughout the country as a whole, the present position is that, after the eleven-plus examination each year, 20 per cent of the children are allocated to grammar schools and 4 per cent to technical schools; the rest go to modern schools. Among local education authorities, however, there are wide discrepancies. In parts of Wales, for example, as many as 60 per cent of the children in an area go to grammar schools; in some schools in the north-east of England the numbers are as low as 12 per cent. Many educationists believe that in some areas far too many children are drawn off to grammar schools.

With all the inadequacies of the eleven-plus examination, it is doubtful whether the allocation of children to radically different types of courses provided by grammar, technical and modern schools gives anything like a fair or natural selection at the age of eleven years and whether this is in the interests of the children affected or the community at large. With the existing tripartite system, it may well be that educational parity can never be achieved and that the system is wasteful as a means of making good use of children's aptitudes and abilities. Advocates of the comprehensive school find most of their arguments in the weaknesses of the modern school. It is good that a few comprehensive schools are being established; the true educationist refuses to accept comprehensive schools as pawns in political manœuvrings, but welcomes them as experiments which may, in time, lead to the setting aside of the tripartite system adopted in 1944. In the meantime, the majority of children find themselves in modern schools, and the nation has a duty to provide them with the best possible education. What has the P.E.P. investigation revealed?

"The central principle of the present system is that every child should change his school at the age of eleven and should spend the remainder of his school career in an establishment which is 'well equipped and well staffed'. In many places, in the absence of buildings in which to house a secondary modern school, education up to the age of fifteen has had to continue in the senior classes of primary schools. In January 1954 there were still 212,770 pupils in such classes distributed between 3,957 schools. It can still be said that one child in eight of secondary age is not receiving secondary education even in name. Many of the other seven are in schools so inadequately housed and equipped as scarcely to be worthy of the epithet 'secondary'. Comfort has to be derived from the reflexion that this state of things is being gradually overcome. By October 1954, 421 new secondary school departments had been completed since the War, providing for about 148,360 children. Some reorganization is going ahead in rural

schools but in urban areas it is still lagging behind."

The maximum size for a class in a modern school is set, officially, at thirty pupils. In 1948 67·1 per cent of the classes in secondary schools had more than thirty pupils; in 1954 the figure was still 53·5 per cent. The position is expected to deteriorate during the years between now and 1961 as the children of the peak birth-rate years pass through the modern schools.

The increase in the proportion of graduate teachers in modern schools has been relatively slight. In 1948 there were 15·4 per cent in modern, 47·9 per cent in technical and 78·2 per cent in grammar schools; in 1954 the numbers were 15·9 per cent, 47·4 per cent and 79·0 per cent, respectively.

Besides the difficulties of providing suitable buildings and staff, local education authorities in some areas have to deal with factors which profoundly influence the status and even the function of modern schools. In some places there has been a greatly increased demand for grammar school education which has depressed the intelligence-level of those attending the modern schools. Similarly, in districts where there are technical schools, the modern school not only faces competition for pupils but also has a reason for not emphasizing the technical side of its own studies. All in all, the modern school is still regarded as the Cinderella of the secondary school system of Britain and, most important, in the eyes of many parents stands for little more than perpetuation of the old elementary school despite the change of name.

In the country as a whole, modern schools have only one feature in common: their pupils have not reached the standard required for entry into grammar or technical schools. They represent a wide range of ability from gifted pupils at the top to a minority of 'educationally sub-normal' or backward pupils at the bottom. The latter form about 10 per cent of the school population and, in favourable circumstances, are taught in separate classes and make good progress. At the other extreme are more gifted pupils, many of whom could benefit from a grammar school education. Some of these are, in fact, transferred to grammar schools at the age of thirteen, while others are given a measure of academic education leading to the General Certificate of Education inside the modern school. The problem of 'transfers' is accentuated by the not unnatural reluctance of modern school heads to allow their schools to be stripped of those able scholars who set both the moral and academic tone of the school.

Some children at secondary modern schools are not academically outstanding but possess considerable practical skill. Yet educational theory is against vocational specialization before the age of sixteen. This places the modern school in the dilemma of having to decide what sort of pre-vocational training is suitable for these children. A greater dilemma is how to deal with the majority of 'average' children who have no discernible special bent and are most likely to be employed in factories on semi-skilled repetition jobs. Should the schools continue with general education alone, or should there be an attempt to make at least some preparation for their future employment?

In some areas courses have been developed for older modern pupils which are linked with their possible opportunities in employment and the further education required. Many employers appreciate the evidence of achievement which these courses provide; but among secondary modern teachers there is still much controversy on four points which are fundamental to these developments: the degree of specialization; the age at which specialization should begin; the need for examination; the importance of staying on at school beyond the age of fifteen.

The development of courses which are in some way related to future employment varies throughout Britain; these courses are probably to be found in rather less than half the educational areas in England and Wales. Some are related to the General Certificate of Education, some are specially devised for those boys and girls who stay on for a fifth year, and some form a normal part of the school curriculum from the child's second year. An inquiry by the National Union of Teachers shows that there are obvious similarities in all the arrangements; but marked differences are also discernible. Some schemes are organized from above, while others spring from the schools. Throughout the country the courses include catering, distributive trades, commerce, domestic science, engineering, automobile engineering, house maintenance and furnishing, craftsmanship for the General Certificate of Education, pre-apprenticeship and pre-nursing courses, farming, gardening, seamanship, electrical science and building. The fact that, despite sincere opposition inside some of the schools themselves, these courses are spreading is evidence that they are becoming an accepted part of the curricula of the modern schools and that they are helping to give these schools a stamp and tradition of their own. The dilemma is that special provision for children at top levels might mean that the needs of the great bulk of the children in the modern schools will not be met.

A special problem which modern schools have to face is that pupils are allowed to leave at the end of the term in which they are fifteen. For many children this destroys the possibility of a rewarding 'fourth' year and makes it difficult to plan useful pre-vocational or vocational courses. It is unlikely that early legislation could be introduced to change this, and the solution seems to be the introduction of incentives to encourage children to complete the academic year; the majority of employers would prefer this to end in January rather than in July. Many parents are anxious to allow their children to continue at school if there is clear evidence of advantage connected with employment opportunities or if it is seen to be of benefit to the child. A link between the schools and technical colleges seems essential at this stage.

The outstanding issue, however, is that of examinations. Despite the widely held belief that modern schools should remain untrammelled by the so-called

tyranny of examinations, many schools feel the need to offer their pupils the chance of measuring their standards of achievement by examinations of one kind or another. The teachers who believe that some kind of stimulus is needed are encouraged by those parents who refuse to keep their children at school beyond the age of fifteen unless an examination is in prospect. Many of the special courses in the modern schools are based on the syllabuses of the General Certificate of Education, although not usually on the academic subjects of the General Certificate. Nevertheless, it is generally agreed that the General Certificate of Education is an unsuitable examination for most modern school pupils. The examinations of a few professional bodies like the Royal Society of Arts or Pitman's College are suitable for those engaged in studies of a mainly vocational kind; but on the whole these are regarded as being too specialized.

In a recent circular* the Minister of Education has made it clear that he does not favour a new general examination for modern schools, nor the use of external examinations for any pupil under the age of sixteen. This does not mean that the Minister is against examinations in modern schools. He is rightly anxious that the interests of the majority are not sacrificed to the needs of the few. Experiments by groups of schools organizing their own examinations would be welcomed so long as the schools retain control over their own syllabuses. Here, surely, is an opportunity for university institutes of education to give a lead. Why should not regional panels representing academic staffs of modern schools, staffs of university education departments and training colleges and local industrialists be formed to devise courses and examinations suitable for the needs of secondary modern pupils, relevant to the requirements of local industries and acceptable to parents and employers? These could be related to the preliminary courses of further education institutions as well as the early stages of achievement required for the Duke of Edinburgh's Award in rescue and public service, training, expedition, pursuits and fitness, the details of which have recently been announced. These courses and examinations could form the bridge both between school and employment and the leisure-time pursuits of the schoolboy and those of the developing adolescent in industry and commerce. Such a proposal would do much to develop local pride in the modern school. Most important of all, it would give the modern schools something which so many of them appear to lack at the moment—faith in their ability to produce good citizens in an industrial society. For encouragement they should examine those schemes which are already in being in different parts of the country. They should also remember that discerning employers already prefer to select their apprentices from successful modern school children rather than from grammar school 'failures'.

* Examinations in Secondary Schools. Circular 289. (Ministry of Education.)

SCIENCE AND MODERN LIFE

Science and Modern Life

By Sir E. John Russell. (Beckly Lecture for 1955.) Pp. iv+101. (London: Epworth Press, 1955.) 6*s.* 6*d.* net.

IN this Beckly Lecture, presumably somewhat extended in published form, Sir John Russell has indicated some of the more difficult problems raised by the ever-increasing force of the impact of science and technology on our social life. Incidentally, he has touched on many other matters, currently discussed at several ranges of temperature. Through his long, very active life as chemist, agriculturist and man of affairs, he has travelled widely, met all kinds and conditions of men and, endowed with a sympathetic outlook, faculty of keen observation and retentive memory, has produced a most interesting, kaleidoscopic survey.

The large number of topics touched upon in a hundred short pages necessarily involves a cursory treatment of most of them, and no deep analysis of any one subject could be attempted. Nevertheless, the book is highly stimulating and can be warmly recommended to the general reader. At the outset the co-existence of a scientific and religious discipline in some early pioneers is noted, and at the end Sir John, for almost the first time in these pages, allows himself to express a definite personal view that hope for the future lies in the co-operation of science and religion in solving the serious and complex problems of human relationships. Again, he says "that the solution [of new social and ethical problems] lies in a more effective infusion into our lives of the spirit of Christianity". Taken quite literally the statement is unexceptionable, and the context shows that the emphasis is on the ethical system rather than on the dogmatic framework. An important question remains begged; but the author, as a scientist, probably wishes to see his own house in order and feels no urge to inquire into the lag period, differing according to the circumstances, in bringing religious dogma into line with knowledge of the natural world. Apart from this moral of the story, the bulk of the work is essentially a factual record, and only here and there will occasion be found to cavil at the statements made.

Many readers will think that the trend of the section on pp. 51–56 goes quite the wrong way. Contrary to the author's suggestion (p. 52), there seems no good reason to suppose that the existence of heredity involves the gradual deterioration of the race as an inevitable consequence. As Calverley said in another connexion, "we're not as pussies are", and surely we have more control over our destiny as a race than, say, carnation cuttings have over theirs. Admittedly it is hard to get a yard-stick in these matters; but the statements in regard to the quality of university students are contrary to the views of some teachers of long experience. In the opinion of many of us, the average calibre of present-day students is certainly no less than that of their predecessors. Nor is there any evidence of the shortening of the range of brilliance so as to produce a dead level of mediocrity.

A feature of the work which will be much appreciated is the references, which are valuable indications for further reading over a wide field.

In this little book there is sunshine and gloom, and perhaps rather more of the latter for the simple

reason that the author has focused his attention chiefly on problems and difficulties. We should be most grateful for such a sincere expression of the thoughts and reactions of so eminent a scientist and administrator.

Robert Robinson

MODERN PHYSICS WITHOUT TEARS

Atoms and the Universe

An Account of Modern Views on the Structure of Matter and the Universe. By Prof. G. O. Jones, Prof. J. Rotblat and G. J. Whitrow. Pp. 254+31 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1956.) 25*s*. net.

In this book the authors have attempted an overall review of modern discoveries and ideas in physics and astronomy within the space of 250 pages. Though, in doing this, they have, as they say, had "to abandon one of the main characteristics of scientific method—its insistence on rigour in argument and explanation", the result is almost completely successful in giving the reader a convincing sketch-picture of recent achievements.

With my own specialized knowledge of atomic physics, I found the astronomical part of the book of greatest interest. This is extremely concise and close-packed with interesting facts and speculations. It is beautifully illustrated with a number of plates of planets and nebulæ. But it is quite possible to imagine an astronomer who would be more interested in the part of the book dealing with atomic physics.

The only unsatisfactory part of the book is that in which the authors try to explain very briefly the ideas of relativity and quantum mechanics. This was probably an impossible task; but I think that more than two pages might have been devoted to experiments and illustrations of the wave-properties of matter and that the considerations of the level-structure of atomic and molecular systems might have been amplified, since a great deal of the astronomical section involves knowledge of spectra and the shifting of spectral lines by the Doppler effect (beautifully illustrated, it is true, but nowhere explained).

But it would be surprising if one could not pick holes in such a book. It is very pleasant to see that the authors have found it possible to describe in simple, non-mathematical terms so much of modern physics and astronomy. There must, of course, be a limit to such an attempt. Quantum and general relativity ideas are not only less familiar than classical ideas, they are also more difficult to understand and to deal with. The Uncertainty Principle sets a limit to one's knowledge, especially to the knowledge one can express in familiar terms. Fortunately, much of physics is still 'classical', if we can tack on such fundamentally non-classical, but easily understood, developments as radioactivity. Astronomy is nearly 'classical' if one accepts the Einstein equivalence of mass and energy, and the motions of fundamental particles are mostly 'classical' until we have to deal with interactions, which involve various diffraction effects. Thus there is a large section of modern physics which can be visualized in more or less classical terms, and the authors have rightly exploited this. Indeed, the ordinary physicist should do just this in his experimental work—he should try to think things out for himself as simply as possible, if sometimes inaccurately, rather than wait for the pure mathematician to tell him all the answers.

I am sure that many of the simplified discussions in the book will prove of interest even to the professional in physics and astronomy. As a review of modern discoveries in these subjects, the book is excellent for the scientist who does not specialize in them. It certainly should be read by all students of physics or applied mathematics as a supplement to their formal text-books, and it can also be strongly recommended to the layman who has some background knowledge of physics.

H. W. B. Skinner

CRYSTAL PHYSICS

Handbuch der Physik

Herausgegeben von S. Flügge. Band 7, Teil 1: Kristallphysik, 1. Pp. vii+687. (Berlin: Springer-Verlag, 1955.) 122.50 D. marks.

This book is one of the first parts to appear of the new "Handbuch der Physik"; together with Part 2 of Vol. 7, it will form a complete work on crystal physics. The necessity for two parts gives some idea of the importance of crystal physics to the other main branches of science. The book contains four sections: crystallography (102 pp., by H. Jagodzinski, in German); theory of the mechanical and thermal properties of crystals (221 pp., by G. Leibfried, in German); the specific heat of crystals (58 pp., by M. Blackman, in English); and the theory of lattice faults (283 pp., by A. Seeger, in German). There are two useful indexes giving the German–English and English–German equivalents of a large selection of technical terms. There is no name index.

Each paper is well documented by reference to works in German and English; relatively, there are few references to work in other languages. It is probable that these references will prove to be the most important part of the book, for in the space available some of the sections are rather cramped. Consider the section by Jagodzinski, for example; in one hundred pages it covers formal crystal symmetry, the relation between symmetry and physical properties, descriptions of some basic structures, and the relation between crystal structure and physical properties. The author has introduced several new ideas into the presentation of space-group theory, and I am particularly pleased to see that his treatment does not take the existence of the Bravais space-lattices for granted. On the other hand, there is a section entitled "Ein Weg zür lückenlosen Ableitung der 230 Raumgruppen" which disposes of the subject in four pages of text.

There is, unfortunately, a small degree of overlapping with the next section, by Leibfried, whose main object, however, is to give a general review of the theory of interatomic forces rather than to describe their effects in particular crystals. It is rather heavily mathematical, descending only occasionally to compare theoretical results with experiment, and omitting completely any descriptions of experimental methods. Experimentalists, however, should find this section useful in showing what type of experimental result is most useful in the general theoretical development of the subject.

Leibfried's and Blackman's sections again overlap appreciably; both discuss the Debye theory in some

detail and its modification by Born and others. Blackman's account provides a very useful summary of the present state of the subject of the specific heats, and is of value to both theoretical and experimental physicists. It shows what an important part the characteristic temperature plays and also, unfortunately, what a complicated concept it has now become.

The final section, on lattice faults, is likely to be the least useful to the English-speaking world, solely because there are so many papers in English on the subject; about four-fifths of the papers in the bibliography are in English. For this same reason, it should be valuable to the Germans, and may give some incentive to them to apply their analytical powers to a new, fascinating and practically important branch of crystal physics.

The general impression remains of a thoroughly competent and able piece of work, rather ponderous perhaps, but of the general style that one expects in an encyclopædia. H. LIPSON

THE WREN IN BRITAIN

The Wren

By Edward A. Armstrong. (The New Naturalist Series.) Pp. viii + 312 + 8 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 30*s*. net.

IT is a sobering thought that, of the 280 species of bird which spend a substantial part of their lives in the British Isles, we still only have adequate and up-to-date monographs of a bare dozen. David Lack's "Life of the Robin" (1943) set a new standard, which has been well maintained by the seven books devoted to individual bird species that have appeared in the New Naturalist Series. The latest of these, by the leading British amateur worker in bird behaviour, is on the second smallest British bird, the wren (*Troglodytes troglodytes*). Though the book is formally devoted to the familiar European species, in fact, such is the wealth of comparative material presented that it almost becomes a treatise on the wrens of the world. This is an immensely valuable feature of the book, for students of British birds are more than usually prone to the myopic views engendered by insularity. Again and again, obscurities in the habits and biology of a British species can only be resolved by reference to the populations of the same bird in other parts of its range, or to quite different members of the same genus or family.

Ornithologists will all regret the author's statement in his preface that "the requirements of this series have necessitated drastic abbreviation and condensation", for it is always less convenient to have to turn to other sources for a complete conspectus. Thus, for extended information on parasites and nidicoles of the wren, one must now turn to the author's paper in Vol. 11 of the *Irish Naturalists' Journal*. However, authors must bow to economics, and ornithological readers must be thankful for being allowed to have as much between two covers as they are offered in this book. The work contains, in fact, a very adequate treatment of every important aspect of the life-history of the wren, largely based on the author's own field studies in a small wood near Cambridge. It is always dangerous to base a general study of a species on the particular circumstances in one locality, but in this book the author's wide reading, together with extensive field studies of wrens in other parts of the British Isles, and in Iceland, have obviated as far as possible any bias due to the quirks of Cambridge wrens.

If it were necessary to standardize monographs on birds (which Heaven forbid!), this would make a very satisfactory book on which to base the standard. There are twenty excellent photographs in black-and-white, by the author and others. R. S. R. FITTER

MALAYAN FERNS

Ferns of Malaya

By Prof. R. E. Holttum. (A Revised Flora of Malaya: an Illustrated Systematic Account of the Malayan Flora, including Commonly Cultivated Plants—Vol. 2.) Pp. iv + 643 + 3 plates. (Singapore: Government Printing Office, 1954 [1955].) 20 Malayan dollars.

PROF. R. E. HOLTTUM'S book on Malayan ferns, the second volume of his revised "Flora of Malaya", maintains—even surpasses—the high standard set up by him in the first volume, devoted to the orchids. Van Alderverelt van Rosenburgh's account has long outgrown its usefulness, and an up-to-date and authoritative successor to it was much desired. Not only has the author described about five hundred species of ferns, but he has also provided 362 excellent line-drawings. The descriptive part of the volume is prefaced by chapters dealing with the nature, classification and nomenclature of ferns, followed by an interesting study of Malayan ferns in particular. Keys to identification are also provided.

Prof. Holttum naturally follows his own system of classification, which differs markedly in some respects from that of Copeland. This is no place to compare the two schemes; but mention must be made of the family Dennstaedtiaceae. The name was first proposed by Ching in 1940 for a small homogeneous group of genera centred around *Dennstaedtia*. When Prof. Holttum adopted the same name for a very much larger group of genera, he was doubtless unaware of Ching's work. Holttum's family comprises about seventy genera, as opposed to eight in Ching's scheme, and is so heterogeneous that the author has found it impossible to supply a family description. Subdivided into eleven subfamilies, it embraces such diverse elements as *Davallia*, *Acrostichum*, *Dryopteris* and *Pteris*, to mention but a few. Treated as families, these subfamilies would have invited little criticism since they are compact natural groups. Their amalgamation as a family will be regarded by some as far from natural. The treatment of the Hymenophyllaceae and Gleicheniaceae is frankly conservative, and the smaller segregate genera accepted by Copeland are not adopted. In the case of the Hymenophyllaceae, however, the corresponding segregate name of every species is given as an "alternative name".

A particularly interesting and novel feature of the book is an appendix, prepared by Prof. I. Manton, on the cytology of a hundred species of Malayan ferns. It is to be hoped that Prof. Manton's plea for further investigation of other species along the same lines by workers in Malaya will meet with a favourable response.

Prof. Holttum's book is well printed and commendably free from typographical errors. It should be pointed out, however, that *Ophioglossum pedunculosum* Desv. is now known as *O. reticulatum* L.

O. pedunculosum is a synonym of *O. costatum* R. Br. and is an entirely different species. Also, the varietal epithet '*alternans*' has been inadvertently omitted from the caption on the frontispiece.

It is to the observations accompanying the descriptions that the book largely owes its readability, and there is much to be learned by the specialist as well as by the less-informed reader. Apart from its value to the field-worker in Malaya, the book is essential for all those who have a genuine interest in ferns as a whole. F. Ballard

CHEMISTRY AND PHYSICS OF RADIOACTIVE MATERIALS

Nuclear and Radiochemistry

By Gerhart Friedlander and Joseph W. Kennedy. (Revised version of "Introduction to Radiochemistry".) Pp. ix+468. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 60*s*. net.

In the preface to their earlier work, "Introduction to Radiochemistry", the authors went to some trouble to define the subject. They have had second thoughts since then, and in the preface to this new volume they propose that the field which they previously defined as nuclear chemistry should no longer be regarded as a part of radiochemistry. Radiochemistry is now to be thought of as including chemical manipulations of radioactive sources and much of tracer chemistry. For these reasons, the title has been altered to "Nuclear and Radiochemistry". The old title may have been unsatisfactory and certainly did not please everybody; but, in the reviewer's opinion, the use of the term nuclear chemistry for describing certain parts of nuclear physics is not a happy one.

Whatever the meaning of the title, the book deals very largely with those parts of nuclear physics which are of interest to chemists. The authors have attempted to cover a wide field by selecting elegant and economical methods of presentation. They have, on the whole, succeeded admirably; only in a few instances has economy been carried too far. In Chapter 2, for example, the section on isotope separations has been reduced to a bare statement of techniques available.

The book is intended primarily for graduate or senior undergraduate students, and emphasis is very properly laid on ideas and principles. The research worker cannot, therefore, expect to find the degree of detail in chapters such as that on radiation detection and measurement, which he requires for his day-to-day work. On the other hand, few research workers in the field of radiochemistry will care to do without a book which contains such a wealth of carefully selected information on the physical background to the subject.

The authors have devoted rather a small fraction of their space to chemical aspects, and the treatment is often quite elementary. Radiation chemistry, which was excluded from "Introduction to Radiochemistry" as not strictly belonging to the subject, has been accorded a brief section in the new volume. This is probably desirable in order to round off a valuable chapter on interaction of radiations with matter. There is a statement, however, to the effect that "most organic systems are much too complex to encourage any detailed studies of the mechanism of their radiation decomposition", which is surely too pessimistic. The problem may be more difficult than that of organic pyrolysis, but modern analytical developments give grounds for better hopes. New chapters, on nuclear energy and on some cosmic problems, have been added in the new volume, and they make a useful addition. It is curious to note, however, that the section on chemical processing seems to be out of line with recent publication in this field. A coprecipitation process is chosen by way of example, and doubt is cast on the suitability of solvent extraction methods because of radiation effects; actually it has been common knowledge for some years that solvent extraction methods are in fact used.

Each chapter is followed by about a dozen well-chosen exercises, and there are about forty pages of appendixes devoted to a most useful compilation of nuclear data. This is an outstanding book, well conceived and well written. It can be strongly recommended to all radio (and nuclear ?) chemists.

THE FIRST HUNDRED YEARS OF THE CURTIS MUSEUM, ALTON

The Curtis Museum, Alton, Hampshire, 1855–1955

The First Hundred Years of a Small Museum. By William Hugh Curtis. Pp. vii+55+10 plates. (Alton: Curtis Museum, 1955.) 6*s*.

It is now fully realized that much of the visible evidence of the heritage of Great Britain lies in the numerous small museums scattered unequally throughout the land. The consciences of the trusts, societies and public authorities owning these institutions have been awakened to their responsibility, and a very great amount of energy and enthusiasm is being expended into transforming these one-time hoards of junk into displays worthy of the best of modern trends in the museum world. A great deal of the credit for this must be given to the Carnegie United Kingdom Trust, which, with the Museums Association, has done much to stimulate and inspire the local museum.

The history of the Curtis Museum in Alton, Hampshire, during the past one hundred years is interesting and instructive not only for its own sake but also as an indication of the trend of development in so many of the museums of Britain. It is written in a clear, straightforward manner by Mr. W. H. Curtis (a grandson of the founder, Dr. William Curtis), who is probably the only one living who could write such a record of what has been so essentially a family concern.

It was in 1837 that William Curtis founded the Alton Mechanics Institute, which, like so many others, led to the establishment of a Museum in 1855. It started with about four thousand specimens, many of which were fossils and minerals, though in common with museums of that period included a quantity of foreign material of all sorts. In 1920 the Museum was transferred to the Alton Urban District Council, and Mr. W. H. Curtis was appointed honorary curator. It is interesting to note that in 1929 the acquisition of bygones was a definite feature in the policy of the Museum—the swing of interest from natural history had begun. At first efforts were concentrated on agricultural, domestic and personal objects, but eventually the search for the tools of rural craftsmen was actively pursued.

An important event in 1934 was the inaugural meeting of "The Friends of the Curtis Museum", a body which has done much for the Museum and continues to the present day. In 1946, the Museum was transferred to the Hampshire County Council under the terms of the Education Act, 1944. A grant from the Carnegie Trust was announced in 1949, and this helped the Museum to assume the modern aspect which characterizes it at the present day. In 1951 the appointment of a full-time curator brought the Museum into line with so many similar institutions up and down the country. The history concludes with an appreciation by Mr. C. P. Chatwin on the geological work of William Curtis.

This stimulating, almost year-by-year, record of the vicissitudes of a local museum is of interest not only to the community in Alton but also to the wider museum public, who see in it an epitome of what has happened at so many centres.

PATHOLOGY OF CANCER

The Genesis and Prevention of Cancer

Second Edition. By W. Sampson Handley. (London: John Murray (Publishers), Ltd., 1955.) 21*s*.

THE first edition of Mr. W. Sampson Handley's book appeared a quarter of a century ago. Although this new edition has recently been revised, the author's original ideas as to the cause of cancer remain unchanged. Many theories of the causation of malignancy are discussed and discarded. The virus theory is dismissed, and the author predicts "no specific organism of cancer will ever be discovered". Mr. Sampson Handley contends there is a definite correlation between the induction of cancer and lymph-statis. This theory was gradually built up over twenty-five years of clinical and histological study of the disease in all its many manifestations. He marshals evidence for his conclusion that precancerous lesions are areas in which the lymphatic vessels have either been blocked or else obliterated by chronic inflammation or congenital defect. He further argues that, as lymphatic obstruction always precedes cancer, it is therefore the main factor in causing the disease.

This view, although not universally accepted by pathologists as the cause of cancer, might hold for some types of malignancy. It would be an oversimplification to accept this theory as the universal cause of cancer. For example, it would be difficult to explain the origin of some forms of endocrine cancers, which depend on hormones both for their induction and maintenance, and which regress once the hormonal stimulus is withdrawn. Under such conditions, do accompanying changes first occur in the lymphatics before the onset of the disease, and can they be expected to disappear during regression? If so, they have not been adequately demonstrated.

Mr. Sampson Handley has done admirable pioneer work on the pathology of breast tumours, and has contributed greatly to our present knowledge of the spread of tumours via the lymphatic pathway. Although many might find his theories controversial, they will also find them stimulating. All who are interested in the histology of the early development of tumours should read this book.

There is also a chapter on cancer prophylaxis. Among the many preventive measures discussed, preputiotomy in children is recommended at birth in order to reduce the incidence of cancer both of the penis and the cervix. In this same chapter, when discussing constitutional factors such as hormones in the etiology of the disease, he contends that they "play only a subordinate part". This attitude is scarcely in accord with modern biological findings.

The book is well illustrated and has an appendix entitled "Tobacco and Cancer", in which some interesting statistics are given concerning lung cancer and other diseases occurring among heavy smokers.

CHROMOSOMES OF HIGHER PLANTS

Chromosome Botany

By Prof. C. D. Darlington. Pp. xii+186. (London: George Allen and Unwin, Ltd., 1956.) 16*s*. net.

IN this useful little book are summarized the important facts and points of view concerning the chromosome numbers and chromosome morphology of the higher plants (chiefly the Angiosperms), and the significance of their cytology in clarifying the taxonomy, phylogeny, geographical distribution and ultimately the evolution of the plants concerned. The facts and points of view are mainly those which have emerged during the period 1930–56; approximately the period since the publication of the first edition of the "Recent Advances in Cytology". Most of the topics dealt with in this epoch-making book have now received a revised treatment from the author in the several volumes written independently or in collaboration with Prof. K. Mather. The present volume brings to a considerable degree of completeness an achievement represented by books which are essentially challenging presentations of facts rather than dispassionate compilations. The reviewer does not forget that compilations and a practical handbook have been provided as well.

B-chromosomes, apomixis, microspecies, polyploidy and plant geography, ecological variation, change of basic chromosome number, change of chromosome morphology and chromosome size, centres of diversity, wheat, maize, *Rosa*, *Chrysanthemum*, are among the subjects treated, often with useful detail. On certain of them it has long been desirable to be able to quote the author's views. On the whole, these views do not differ markedly from those generally held, although, as always, it would be easy to quote sentences from this author with which few would agree. There are no complex diagrams. The sections dealing with basic numbers are particularly illuminating, although the bold assertion of 1949 in regard to the basic chromosome number of the ancestral Angiosperms is repeated here and their seven chromosomes appear on the dust-cover. Broadly, the book is an elaboration of the introduction to the first edition of the "Chromosome Atlas".

There is a separate bibliography for each chapter; but authors' names are also indexed. One feels that the names of some whose ideas have been assimilated, perhaps subconsciously, should not have been missing, for example, those of Huxley and Turrill; yet, of course, it is an advantage that the size of the volume has been kept down to that which a student can afford to buy. Every serious student of botany should be recommended to purchase this book, the only one of its kind published in Britain. There is an informative little appendix by E. B. Ford, on moths, butterflies and *Primula*. M. B. E. GODWARD

AMEDEO AVOGADRO (1776–1856)

By Prof. J. R. PARTINGTON, M.B.E.

PROBABLY no name is better known to students, even the most elementary, of chemistry and physics than that of Avogadro; but this was not always so. He is not mentioned in the detailed histories of chemistry of Hoefer and Kopp, and in the biographical dictionary of Poggendorff he first appears in the third volume in 1898. The details of his life are to be found only in the very rare "Opere Scelte di Amedeo Avogadro", printed for private distribution by the Turin Academy of Sciences in 1911, the centenary of the publication (in French) of his famous hypothesis in the widely read *Journal de Physique*. The "Opere" has a long introduction by Prof. Icilio Guareschi and contains the first Italian translation of Avogadro's memoir of 1811. It also prints a letter from Faraday in 1842, thanking Avogadro for his last letter and saying (the letter is in Italian) that he had read the first two volumes of his great work with much profit, "sebbene io legga l'italiano con stento". This would be the "Fisica de' corpi ponderabili" (4 vols.; Turin, 1837–41), and Faraday says he had ordered the third volume from Paris.

A member of a distinguished Italian family, Amedeo Avogadro (to use his own contraction of his very long complete name) was born in Turin on August 9, 1776, and died a hundred years ago on July 9, 1856. He became bachelor of law in 1792, later doctor of eccelesiastical law (a family vocation), and practised for a time. He became interested in mathematics and physics, and in 1809 was appointed professor of philosophy in the Royal College of Vercelli. In 1820 he filled the first Italian chair of mathematical physics in Turin, which was suppressed for political reasons in 1822. The chair was restored in 1832 but was occupied for a year by Cauchy, the distinguished French mathematician, when it was re-occupied by Avogadro from 1834 until his retirement in 1850. The "Opere" lists more than fifty publications by Avogadro—all except the memoir of 1811 known only to specialists. He took an active part in public affairs and was a very cultured man with many friends among distinguished scientists in all countries; but he received no honours, partly because of his modesty and partly because he was so fully occupied with scientific work that he had no time to seek them.

Avogadro's famous memoir of 1811 is entitled "Essai d'une manière de déterminer les masses relatives des molécules élémentaires des corps, et les proportions selon lesquelles elles entrent dans ces combinaisons". He uses the names "molécule" and "molécule intégrante" for molecules in general, "molécule constituante" for a molecule of an elementary substance, and "molécule élémentaire" for the atom of an element. The title, therefore, shows that he is concerned, in fact, with atomic weights. The nomenclature and the clumsy and sometimes obscure French in which the paper is written make it difficult to understand. It announces the hypothesis that "le nombre des molécules dans les gaz quelconques est toujours le même à volume égal . . . les rapports des masses des molécules sont alors les mêmes que ceux des densités des différents gaz, à pression et température égales". A long supplement, which is little known, appeared in the *Journal de Physique* in 1814.

Avogadro makes it clear that the origin of his memoir was the publication in 1809 by Gay-Lussac of his law of volumes, in the form that gases "se combinent entre elles dans des rapports très-simples, et la contraction de volume qu'elles éprouvent par la combinaison suit aussi une loi régulière". This shows, said Avogadro, that "il y a aussi des rapports très-simples entre les volumes des substances gazeuses, et le nombre des molécules simples ou composées qui les forme". Gay-Lussac read his memoir to the Société d'Arcueil on December 31, 1808; it is purely experimental. In 1808 Dalton, in the first volume of his "New System of Chemical Philosophy", had said that "it is evident the number of ultimate particles or molecules in a given volume of one gas is not the same as in another", since one volume of nitrogen and one of oxygen form two volumes of nitric oxide, in which "the number of ultimate particles could at most be one half of that before the union".

This difficulty Avogadro resolved by the assumption that the molecules (a name which, it will be noticed, was used by Dalton) of elementary gases may contain two or more atoms and that the particles resulting from their union may divide. In modern symbols: $N_2 + O_2 = N_2O_2$; $N_2O_2 = 2NO$. In comparing the weights of molecules from the ratios of densities, Avogadro took the molecular weight of hydrogen as unity, so that his molecular weights are half the modern ones.

In 1814 Ampère published the same conclusions as Avogadro, mentioning him only in a footnote, so that Avogadro said in 1849: "Ampère a depuis adopté ce principe". Ampère suggested that the molecules of elementary gases contain four, not two, atoms, and made further obscure speculations about the geometrical forms of the particles. Dumas in 1826 is the only chemist to name Avogadro before 1850; others, when they refer to the hypothesis at all, credit it to Ampère, as did Gaudin, who in 1833 gave a detailed and clear exposition of it, which was favourably noticed by Berzelius.

Avogadro died on July 9, 1856, and his hypothesis was then in a state of full neglect. There were reasons for this. All attempts to construct a uniformly acceptable set of atomic weights had failed, and chemists had fallen back on the use of equivalent weights determined directly by experiment. Dumas in 1826 had found very abnormal vapour densities of sulphur and phosphorus, which had no clear relation to the accepted atomic weights; and, finally, the vapour densities of ammonium chloride, phosphorus pentachloride and sulphuric acid were only half those expected.

In 1858, Cannizzaro, then professor in Genoa, distributed a small pamphlet based on his lectures, in which he cleared up the difficulties of abnormal vapour densities by assuming that the sulphur and phosphorus molecules contain more than two atoms, and that ammonium chloride, etc., dissociate on heating and, thus occupying a larger volume, have abnormally low molecular weights. Cannizzaro showed that Avogadro's hypothesis, which was now restored to its rightful originator, could be applied

without exception. He referred both atomic and molecular weights to the *atom* of hydrogen, instead of (as Avogadro did) to the molecule; the ratio of the molecular weight of any gas or vapour to that of hydrogen is the ratio of the densities, and since the hydrogen molecule is H_2, the molecular weight of the other substance, in terms of the atomic weight of hydrogen, is twice the relative density. The atomic weight of an element is then the smallest weight of it contained in a molecular weight of any of its compounds. These two features are important contributions by Cannizzaro.

Lothar Meyer was much impressed by Cannizzaro's pamphlet, and in his "Moderne Theorien der Chemie", published in 1864, he gave a clear account of the bearing of Avogadro's hypothesis on molecular and atomic weights. A similar service was rendered by Hofmann in his "Introduction to Modern Chemistry" in 1865. From that time the significance of the hypothesis came to be clearly perceived, and it now ranks next to Dalton's atomic theory in the structure of theoretical chemistry.

The kinetic theory of gases, developed by Clausius (1857) and Maxwell (1860), showed that Avogadro's hypothesis (they do not mention his name) follows from the assumption that the average kinetic energy of translation of gas molecules is proportional to the absolute temperature, and the significance of the hypothesis was thus seen by physicists. Avogadro was, in fact, a mathematical physicist, not a chemist in the proper sense. The hypothesis was seen to penetrate such diverse branches of physics as the kinetic theory, the Brownian movement, radiant heat, the scattering of light, the electronic charge, and the counting of α-particles. It became possible to determine the number of molecules in a molecular weight in grams of any substance, a constant of Nature now called Avogadro's number and equal to $6{\cdot}02 \times 10^{23}$. If it can be said with truth that the real existence of atoms and molecules has been experimentally demonstrated, it can be asserted with equal confidence that Avogadro's statement is no longer what he himself called it, a 'hypothesis'. A generation ago, students were warned by meticulous teachers not to call it Avogadro's 'law'; but this name would now seem to us much less objectionable.

Avogadro did not live to see the full recognition of his great service to chemistry and physics. Now, however, in commemorating the centenary of his death, no obscure name is rescued from oblivion but homage is paid to one long acknowledged as a master.

FINE STRUCTURE OF SOME CILIATE PROTOZOA

By Prof. J. T. RANDALL, F.R.S.

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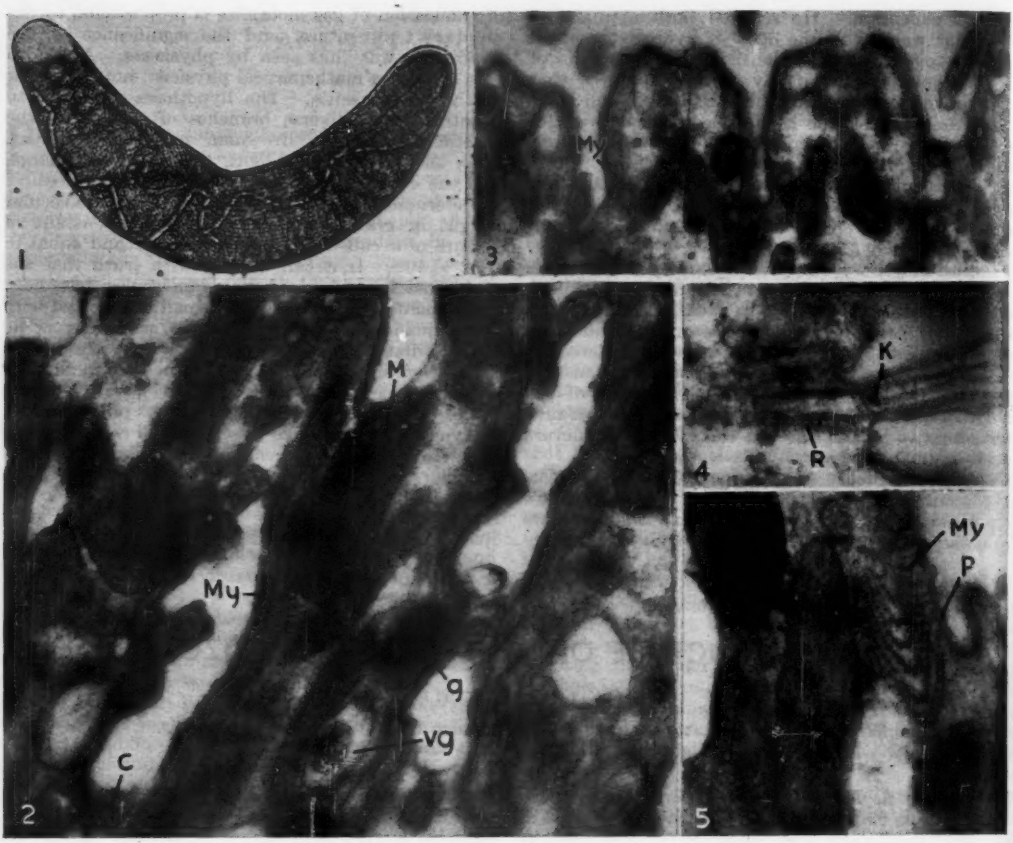
In this article I wish to outline some of the more important features of the fine structure of certain ciliates which have been observed in the electron microscope. Most of the currently accepted information about Protozoa has been obtained with the help of the light microscope[1,2], and has clearly been restricted by the limited resolving power of this instrument. It is surprising that, in the ten or fifteen years during which the electron microscope has become an increasingly important and popular tool in the study of biological fine-structure, the study of Protozoa has been a comparatively neglected field. The start given to such investigations by Jakus and her collaborators[3–5] does not seem to have been followed, until very recently, to the extent that might have been expected. This is probably accounted for by the fact that Protozoa are in general rather large and thick organisms for study in the electron microscope without the aid of the thin-sectioning microtomes which have themselves only been developed in the past few years.

In the field of biological fine-structure, Protozoa offer many attractive possibilities. Among them may be mentioned: (1) structure of the nucleus, the nucleolus and the nuclear membrane; (2) protozoan cytoplasm with its many inclusions; (3) fine-structure of the protozoan pellicle and ectoplasm; Sedar and Porter[6,7] have recently made such investigations for *Paramecium multimicronucleatum* and Powers *et al.*[8,9] have studied mitochondrial structures in *Paramecium* species; (4) ciliary apparatus of the ciliates, including membranelles; (5) contractile structures or myonemata of the ciliates, to which I give special attention below; (6) sexual and asexual reproduction and the phenomena of mitosis in the Protozoa, which also suggest many interesting comparative studies with higher organisms. These are but a few of the approaches that may be made in this interesting field.

In this article I shall be concerned with three members of the Ciliophora: *Spirostomum ambiguum*, *Carchesium* sp. (probably *polypinum*) and *Stentor polymorphus*. The material has been fixed in a combination of osmium tetroxide and Zenker fluids and then embedded in a methacrylate medium. After appropriate polymerization of the plastic, thin-sectioning of the organisms was carried out on a microtome designed in this Laboratory. It has not been possible to illustrate all structural features to which reference has been made in the text, but fuller accounts will be made available as soon as possible; a more detailed description of the work on *Spirostomum* is already in course of publication[10].

Spirostomum ambiguum (Ehrenberg)

This heterotrich has a uniform body ciliation with a funnel-shaped pharynx and a long peristome roughly parallel to the body-axis. The surface of the body (see Fig. 1 for photomicrograph of the living animal) is crossed by perhaps as many as forty kinety along which the cilia are uniformly distributed. The kinety are separated by ectoplasmic ridges. Longitudinal sections through the ectoplasm which cut transversely through a number of cilia may be seen in Fig. 2. Fig. 3 is an electron micrograph of a transverse section through the ectoplasm, and the characteristic ridges and furrows may be seen



Spirostomum ambiguum

(1) Photomicrograph of a living animal showing the longitudinally arranged kinety, the beaded macronucleus, the contractile vacuole and the dorsal canal. × 120

(2) Electron micrograph of an oblique section through the ectoplasm which shows the ridges, transverse sections of cilia (*c*) lying in the furrows, mitochondria (*M*), two types of granular inclusion with — (*vg*) — and without — (*g*) — a vesicular membrane, and longitudinal sections of myonemes (*My*). × 32,000

(3) Transverse section through the ectoplasm showing the ridges and furrows (kinety) at the surface of *Spirostomum*. Myonemes (*My*) are localized asymmetrically at the left side of each ridge. × 16,000

(4) Longitudinal section of a cilium showing its kinetosome (*K*) and dependent root-like fibrils (*R*). × 35,000

(5) Transverse section through the fibrillar myoneme sheets (*My*) which are attached to the inner plasma membrane (*P*) at one end. Note the two types of mitochondrial structure. × 45,000

n this picture. The periplast of *Spirostomum ambiguum* has an overall thickness of about 500 A. and appears to be double. The inner component is referred to below as the plasma membrane.

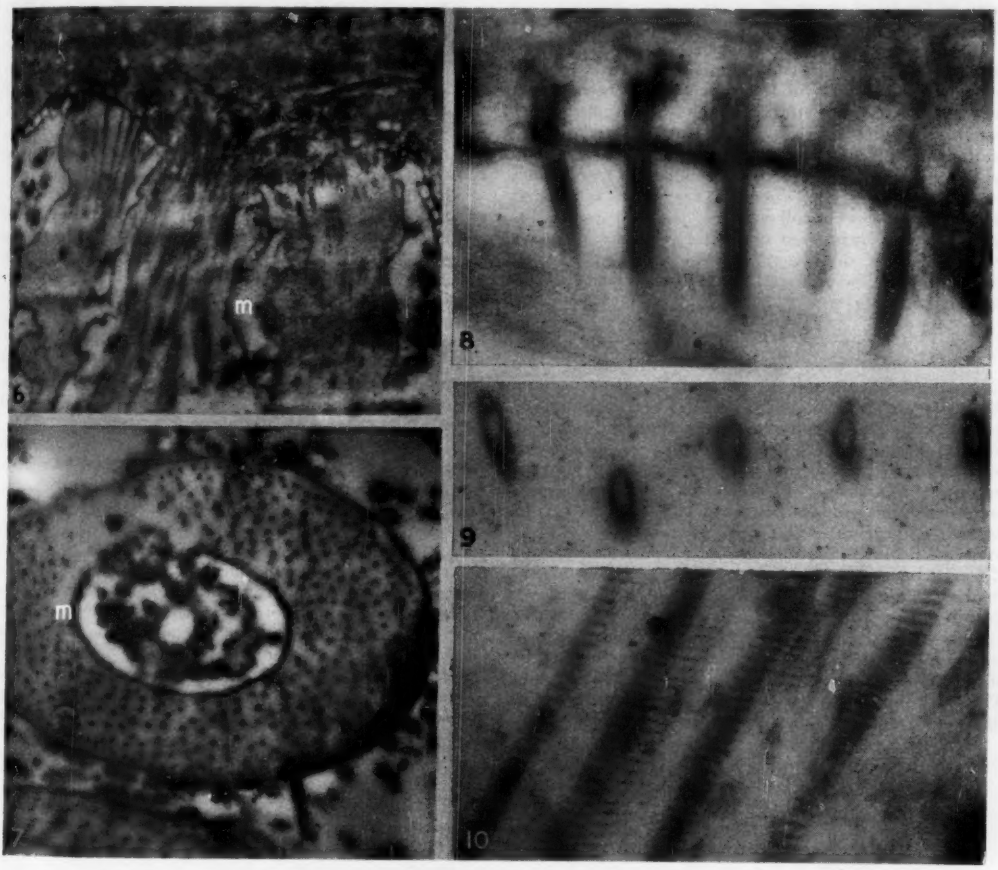
The external membrane of each cilium is continuous with the outer layer of the periplast. This membrane encloses a system of filaments, two of them approximately axial, and nine peripheral; each of the nine outer filaments is, in the best micrographs, resolved into two closely adjacent filaments. Each cilium is about 1500 A. in overall diameter. A longitudinal section through the basal apparatus (Fig. 4) clearly shows a granule, *K*, presumably the core of the kinetosome, which appears to be surrounded by twin septa. From the outer and lower part of the septum two rootlets, *R*, extend into the ectoplasm.

Earlier investigators with the light microscope have naturally given much attention to the problem of the detailed structure of the pharyngeal membranelles (for example, Bishop[11]). On the basis of the evidence I have obtained so far, the view that the motile portion of each membranelle in *Spirostomum* is composed of laterally joined cilia does not seem to be justified. I would, however, prefer to defer conclusions on this complex matter until I have made further observations.

Long, slightly ovoid, bodies with fine structure characteristic of mitochondria have been observed in large numbers in the ectoplasm of *Spirostomum* (Fig. 2). Detailed examination of these bodies has led me to conclude that they may be separated into two distinct groups. In the first group (Fig. 5) the mitochondria are composed of sheets about 150 A. thick which are separated from each other by a layer of less dense—or possibly less osmiophilic—material of rather greater thickness. The total surface area of the sheets inside a mitochondrion represented by a cylinder 1 micron long and $\frac{1}{4}$ micron in diameter would be 1·25 cm.^{2}; each mitochondrion appears to be enclosed in a single membrane. Instead of this simple stratified structure, it is more usual, however, to find a modification in which the internal organization appears to consist partly of sheets (as

above) and partly of small tubular vesicles which are typically elliptical in cross-section (see also Figs. 2 and 5). The lumen of the vesicles is often about 430 A. × 250 A. and the wall-thickness about 200 A. In the paper already referred to[10], it has been shown how such a vesicular structure may have been derived from a system of undulating sheets. The mitochondria that fall into the second group have so far been found only in small numbers in *Spirostomum*, but may be recognized as the type usually observed in metazoan tissues (see also Fig. 14 for *Carchesium*); such mitochondria contain a number of characteristic vesicular structures somewhat irregularly arranged. Without much more detailed investigation it is impossible to say whether the two groups into which I have divided the mitochondrial bodies of *Spirostomum* are really distinct, or whether the second group arises as a somewhat swollen or distended version of the first.

The most elementary observations of living *Spirostomum* show that the animal must possess some means of extremely rapid contraction. The history of the study of the myonemes of *Spirostomum* has been described in some detail[11]; such structures have in the past been inferred from examination by light microscopes of living and of fixed-and-stained material. The electron microscope observations show that the effective width of a myoneme is close to the limit of optical resolution. This accounts for the often conflicting observations which have been recorded. Fig. 3 is a transverse section of *Spirostomum* showing the pellicle and ectoplasm of two ridges and their neighbouring furrows. Attention is particularly directed to the structures, *My*, apparent on the left-hand side of each ridge. These structures are provisionally identified with the myonemes. Each myoneme appears to consist of a number of fibrillar ribbons or sheets, often about ten, which presumably extend the full length of the animal. Fig. 5 shows in greater detail a transverse section of a single myoneme. One side of each ribbon is attached longitudinally to the plasma mem-



Carchesium

(6) Longitudinal section of the junction of stalk and zooid which shows that the cytoplasm is continuous with the central canal; the junction is marked with a root-system, which may have a ciliary origin, and which may be attached to the longitudinal filaments of the annulus. × 3,000

(7) Transverse section of the stalk showing the central canal and the annulus which contains numerous filaments seen in cross-section. × 3,000

(8) Higher magnification of the root-system at the junction of the stalk and zooid. × 35,000

(9) An oblique section of the annulus which shows the tubular form of the filaments. × 32,000

(10) Longitudinal section of the striated filaments from the annulus of the stalk. Periodicity, 300–700 A.; diameter about 1400 A. × 35,000

brane, *P*, on one side of each ridge. There is apparently no permanent attachment of the distal ends of ribbons, each of which is simply embedded in the ectoplasm. The extended width of a ribbon is about 5000 A. The fibrils, which are the main feature of the ribbons, consist of an outer dense layer and an inner less dense core; the overall diameter of the fibrils is about 250 A. (Fig. 5). In longitudinal section the myoneme ribbons appear as narrow lines parallel to the plasma membrane (Fig. 2). The dimensions of the myonemes given above refer to contracted material.

The ectoplasm of *Spirostomum* contains in addition to the mitochondria two distinct forms of granular structure (*g* and *vg*) often about 0·5μ in diameter. The simpler structure (*g*) is composite and contains many small particles with no evidence of an enclosing membrane. The more complex structure (*vg*) consists of an apparently dense multigranular core which is enveloped in a well-formed membrane clearly separated from the inner structure. Both types of granule may be seen in Fig. 2. No such granular structures have so far been observed either in *Carchesium* or in *Stentor*.

In the electron micrographs of *Spirostomum* there is a fairly sharp transition from ectoplasm to endoplasm; no evidence of an intermediary membrane, however, has been found. The endoplasm is heavily vacuolated, and the ectoplasm is connected to the endoplasm through a widely spaced series of canaliculi which separate neighbouring vacuoles from each other. Although the vacuoles are often associated with a number of small vesicles, the features so far recognized by others as characteristic of contractile vacuoles have not been clearly observed. Food vacuoles have been found in many of the sections examined.

Carchesium

This peritrich may readily be distinguished from *Zoothamnium* on one hand and *Opercularia* and *Epistylis* on the other. In *Carchesium* each branch of the stalk is independently contractile; in *Zoothamnium* the whole colony contracts as one. *Opercularia* and *Epistylis* are non-contractile. I am not certain of the species of *Carchesium* examined; but it is probably *polypinum* (see Fig. 11 for a photograph of the animal under the light microscope). Fig. 12 gives a low magnification view of a transverse section through parts of the ciliary system near the mouth of the zooid; notable in the lower part of the micrograph is the triple row of cilia. In another section cut closer to the root system (Fig. 13) each cilium is joined laterally to its neighbours in the same row by short filaments about 1500 A. long and 200 A. wide. The endoplasm in both the above micrographs is filled with mitochondria which are of the vesicular type common to metazoan tissues and are similar to the Type II mitochondria of *Spirostomum*; Fig. 14 shows part of a *Carchesium* mitochondrion at higher magnification. Regions of the endoplasm near the cytostome in *Carchesium* have been found to be in a highly organized state (Fig. 15) reminiscent of the structures found in the mitochondria (Type I) of *Spirostomum*; the significance and extent of this elaborate system of sheets and vesicles, however, are not yet known.

The stalk consists of two distinct parts: an annulus, which is threaded by numerous longitudinal tubular filaments, marked with a periodic striation, and a central core or canal which appears to be continuous with the endoplasm of the zooid and is separated from the annulus by a single membrane, *m* (Figs. 6 and 7). The stalk, after fixing and embedding, generally appears elliptical in section, and the core is about half as wide as the annulus is thick (about 10^{-3} cm.) (Fig. 7). Bodies similar to mitochondria have frequently been observed in the core of the stalk and well removed from the stalk–zooid junction. A primitive type of root system occurs at the junction of the stalk and zooid (Figs. 6 and 8); but precise evidence of the nature of this connexion is so far lacking. The system does not appear to be related in any way to the basal ciliary wreath of a dividing zooid, although it seems extremely likely that it may have a modified ciliary origin. The striated longitudinal filaments of the stalk may be attached to the root system[12].

The filaments of the annulus are seen in longitudinal section in Fig. 10; the axial periodicity of their striations varies widely but generally lies in the range 300–700 A.; in transverse section the filaments are tubular and usually about 1400 A. in diameter. It is tempting to suggest that these striated longitudinal filaments are the contractile structures or spasmonemes of the stalk of *Carchesium*. On the other hand, Rouiller, Fauré-Fremiet and Gauchery[13] have very recently shown that the non-contractile stalk of the *Opercularia articulata* is also threaded with similar striated filaments.

The contractile mechanism of the stalks of such peritrichs as *Carchesium*, *Zoothamnium* and *Vorticella* has generally been associated with the central canal; this feature has not been observed in the non-contractile stalks of *Opercularia* and *Epistylis*. A careful search has therefore been made in *Carchesium* for the existence of possible contractile fibrils in the central canal of the stalk. Suggestive structures have been seen from time to time; but they have not been convincing and give the impression rather of stress regions in a comparatively uniform gel.

Thus in the present stage of knowledge it is possible only to speculate about the nature of the contractile mechanism. The striated filaments

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Figs. 11–16: *Carchesium*. Figs. 17–21: *Stentor polymorphus*

(11) Photomicrograph of living animal showing the zooid and attached stalk. × 350

(12) Low-magnification view of transverse section through the ciliary system close to the gullet. Note the three rows of ciliary roots in the lower left-hand side of the micrograph. × 6,500

(13) Higher magnification of a transverse section through the triple ciliary row seen in Fig. 12 but cut closer to the root system. Each cilium is laterally joined to its neighbour in the same row by short filaments about 1500 A. long and 200 A. in diameter. × 32,000

(14) Part of a mitochondrion of *Carchesium* showing the internal microvilli. × 45,000

(15) Structure of the highly organized part of the endoplasm usually found close to the gullet of the *Carchesium*. × 45,000

(16) A section through part of a nucleus. The dense bodies are positive to the Feulgen stain. × 32,000

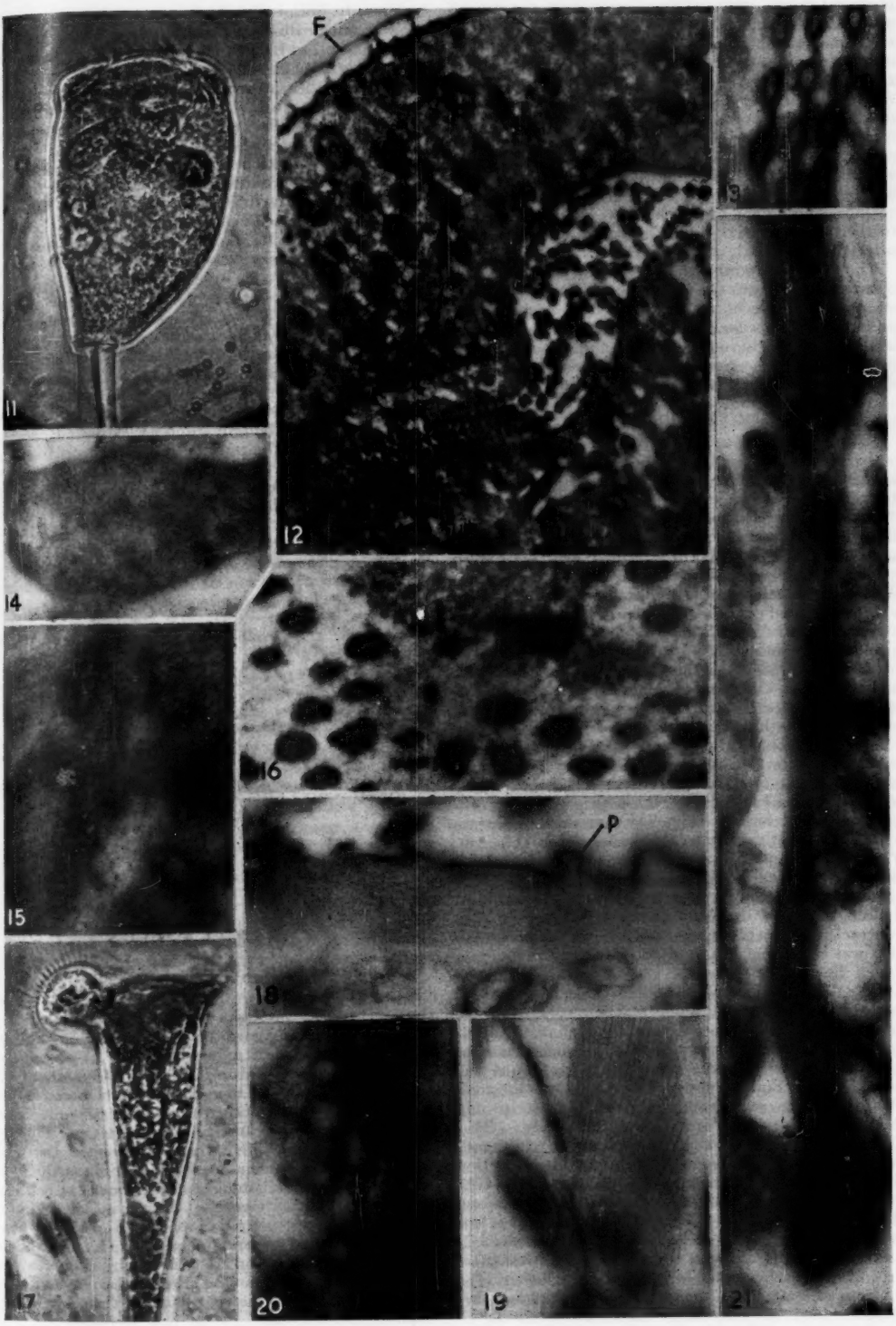
(17) Photomicrograph of living *Stentor polymorphus*. × 200

(18) Longitudinal view of the myoneme ribbons of *Stentor* which lie just beneath the pellicle (*P*). Each ribbon is about 130 A. thick. × 32,000

(19) Near transverse section of the ectoplasm showing groups of ribbon-like myonemes about 5000 A. wide; the myonemes are seen to converge into single dense structures in the lower part of the micrograph. × 32,000

(20) The dense structures of the myonemes terminate at the bases of the cilia and in this transverse section the point of attachment of the myonemes to ciliary roots can be seen. × 42,000

(21) A composite group of adoral cilia with a single extremely long (8–12μ) root system. × 32,000



[See opposite

observed in the stalks of the genera so far examined may all be potentially contractile. The function of the canal and its membrane in contractile species may be analogous to the function of the sarcoplasm and the sarcolemma in muscle fibres. Alternatively, the filaments may not themselves be contractile but may merely perform a strengthening or supporting function. Contractility may be achieved through an as yet unverified system of fibrils within the central canal, through the contractility of the canal membrane, or through the contraction of the amorphous gel surrounding the outer filaments. It is hoped that further comparative studies may help to solve this intriguing problem.

The outer boundary of the zooid of *Carchesium* is quite different from the periplast of *Stentor* or *Spirostomum* and may be seen in transverse section at *F* in Fig. 12. This boundary has a fluted appearance which may be caused by a longitudinally arranged series of tubular structures. The overall width of this system in the fixed material is about 5000 A.

Stentor polymorphus (Müller)

Stentor polymorphus (Fig. 17) is a heterotrich which is trumpet-shaped and, like *Spirostomum*, highly contractile. Only a limited number of the characteristic structures revealed by electron microscopy can be discussed here. In longitudinal sections of the body the most interesting structures are those probably associated with contractility; they are referred to below as myonemes, although it will be again obvious that electron micrographs do not in themselves provide evidence of contractility. Transverse views of the myonemes to be seen in Fig. 19 show them to be not unlike those shown in Fig. 5 for *Spirostomum*; the myonemes of *Stentor* are also situated asymmetrically in each ridge. Present evidence from many micrographs indicates that the myonemes are of indefinite length and in the form of closely associated narrow sheets or ribbons. The coarsely fibrillar structure of *Spirostomum* is not evident in *Stentor polymorphus*. In longitudinal section the sheets appear as a series of closely spaced parallel lines (Fig. 18). Comparison of micrographs suggests that each myoneme comprises about twenty to thirty such sheets (Fig. 18). The thickness of each sheet is about 130 A. and the width about 5000 A. A striking feature of Fig. 19 is the condensation of these sheets into thicker and denser objects; in this form these (presumably contractile) structures are apparently attached to the oral cilia (Fig. 20). In addition, the myonemes which lie in the ridges of the body appear to be attached to the locomotive cilia. This in turn suggests that the ciliary and contractile mechanisms are co-ordinated with one another, and that the contractile fibrils are identical with the kinetodesmata.

Some further remarks must be made about the adoral cilia. Fig. 21 shows that these are in small groups. From each such group an extremely long (8–12μ) root system depends into the body. This system is apparently highly organized; in longitudinal section it is filamentous; in oblique section a lattice-like arrangement is visible, the whole suggesting a regularly arranged system of interweaving sheets. Several very long bodies without clear structural characteristics have also been observed in sections of the endoplasm. It is not known what these are, although they may, of course, be another type or form of contractile structure. Fauré-Fremiet and Rouiller have very recently[12] reported a number of observations on the fine structure of *Stentor* species.

Even at this early stage, mention must be made of the nuclei observed in the three animals so far investigated. In all three the nuclei present a rather grossly granular appearance, and the large granular bodies are composite and react positively to the Feulgen stain. The whole of the space between the granules is filled with very small particles about 100 A. in diameter (Fig. 16). In view of the known difficulties of fixation of Protozoa, the possibility of nuclear artefact cannot by any means be excluded. The recent X-ray diffraction evidence for the long filamentous helical structure of nucleic acid (DNA) in certain intact nuclei makes it all the more necessary to study methods of nuclear fixation with extreme care; and it may be suggested that such methods should be based rather on the expected physical behaviour of polyelectrolytes under defined conditions than on earlier traditions of cytology.

I am indebted to the Botanical School, Cambridge, for the provision of specimens of *Spirostomum* from its collection, and to Dr. J. A. Kitching, of the University of Bristol, for the provision of *Carchesium* and *Stentor*. Dr. Kitching and Dr. Muriel Robertson have been most helpful in initiating me into this field and in the discussion of results. I wish to acknowledge valuable discussion with Prof. E. Fauré-Fremiet, who has simultaneously been investigating similar problems, and with Dr. Jean Hanson of this Laboratory.

It is a pleasure to record the invaluable help of Miss S. Fitton Jackson at all stages of the work.

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OBITUARIES

Prof. A. J. Kluyver, For.Mem.R.S.

During the night of May 13–14, 1956, Albert Jan Kluyver, professor of microbiology at the Technological University of Delft, Holland, suddenly died at his home of a heart attack, at the age of nearly sixty-eight years. The news of his death will deeply affect all who have known him, because they realize that it signifies the loss of a universally beloved personality and great scientist.

For almost thirty-five years he directed the work at his Institute in a manner that has made the Delft laboratory famous throughout the world as a centre of microbiological research. Under the leadership of M. W. Beijerinck from 1895 until 1921, it had already acquired an enviable reputation; and at the time of his succession to the chair, Kluyver was keenly aware of this and hence also of his great responsibilities, especially in view of the very limited training in microbiology he had received. But he possessed an excellent and highly perceptive mind,

and an unrivalled capacity for work. By strenuous and undeviating application he rapidly succeeded in mastering the field, and in a few years he was ready to start developing a programme of his own that has resulted in some of the most far-reaching advances in biochemistry.

His chemical background inclined him from the start to a study of the biochemical activities of micro-organisms. Convinced by an early exhaustive review of the literature on this subject that the existing information did not reach much beyond providing a confusing picture of an almost endless variety of patterns, he began to look for unifying principles. How successful this search has been must be obvious to everyone who is conversant with the fundamental features of present-day biochemistry, which rests squarely on the concepts of the 'unity in biochemistry', and of 'comparative biochemistry' that Kluyver developed in the course of a very short time. These concepts have exerted a fertilizing influence on biochemical progress fully comparable to that which followed the introduction of the comparative anatomical and embryological approach into general biology. The foundation, inception and elaboration of these principles have been brilliantly presented by Kluyver in the series of lectures that he delivered in 1930 before the University of London, published in 1931 by the University of London Press under the title "The Chemical Activities of Micro-Organisms", and in the first two of the John M. Prather Lectures given in 1954 at Harvard University, and recently also published in book form ("The Microbe's Contribution to Biology", Harvard University Press, 1956). It is not too much to say that Kluyver's contributions have been instrumental in establishing the biochemical foundation for Darwin's concept of the monophyletic origin of living beings.

The recognition of the fundamental unity underlying the biochemical activities of extant living organisms should be attributed not only to Kluyver's philosophically inclined mind; equally significant for this development was his profound knowledge of the vast variety of microbes and his perception of their great biochemical potentialities. The possibility of using a particular bacterium, yeast or mould for the investigation of some specific biochemical process has been ably exploited in many studies carried out in his institute. During the first decade of his career as a microbiologist, Kluyver often expressed surprise and regret that this notion was not more prevalent, in spite of his ardent advocacy of its advantages in lectures and publications; he was too enthusiastic to be content with that form of mental inertia that impedes the speedy diffusion of novel ideas. But gradually his admonitions, supported by striking examples of fruitful applications, have had their effect, and developments during the past fifteen years have amply justified the high expectations he had for this type of approach, which has finally been used on a rapidly increasing scale. A consequence of this has been that general microbiology has come into its own as an important branch of biological science, and the reputation of the Delft laboratory has certainly not suffered from Beijerinck's retirement. In fact, the "Delft School" that has so strongly stimulated the rise of general microbiology is a term that properly refers to the period of Kluyver's leadership (see, for example, *Bact. Rev.*, **13**, 161; 1949).

It is, however, not merely the scientific output that has made his laboratory one of the most sought-after institutions, to which microbiologists from all over the world have come to learn from the master. It has been the experience of all who have worked there that he contributed far more than his vast factual knowledge and the penetrating insight of a fine scientific mind. For they have also been exposed to a noble personality who had a deep understanding of human behaviour and a profound appreciation of the meaning of individuality. His whole demeanour was an inspiring example of a life radiating encouragement, tolerance and compassion. This attitude compelled much more than respect, and created in his institute a warm and conspicuous atmosphere of enthusiastic, generous and effective co-operation, of love for work, and of personal responsibility.

The same characteristics also made Kluyver a highly valued adviser, and his services were more and more frequently solicited on important national and international committees, where his wisdom usually led to finding genuine conciliatory solutions rather than compromises for difficult problems.

His outstanding significance as a scientist has been widely recognized. Only five years after his appointment to the Delft chair he was elected to membership in the Netherlands' Koninklijke Akademie van Wetenschappen; during 1947–52 he served as president of its section for natural sciences. He was also a member of many foreign scientific societies; his election as foreign associate of the U.S. National Academy of Sciences, as foreign honorary member of the American Academy of Arts and Sciences, and as foreign member of the Royal Society may be specifically mentioned. Microbiological societies, such as the British Society for General Microbiology and the Society of American Bacteriologists, were proud to count him among their honorary members. A recipient of several honorary degrees and other marks of distinction, he was perhaps most deeply touched when he was awarded the Copley Medal by the Royal Society.

Now his active and productive life has come to an end. Nevertheless, his contributions to science and society will continue through the work of his numerous pupils in various parts of the world. They will be aware of the great obligations which their association with A. J. Kluyver has engendered, and which implies the desire to perpetuate his way of life, to the benefit of humanity.

C. B. VAN NIEL

Prof. J. M. D. Olmsted

JAMES MONTROSE DUNCAN OLMSTED was born of New England forbears at Lake City, Iowa, on May 21, 1886, and died at Berkeley, California, on May 26 just after his seventy-first birthday. Olmsted received an A.B. degree from Middlebury College (Vermont) in 1907 and four years later a B.A. from Oxford, where he was a Rhodes Scholar. He returned to the United States in 1911, served as professor of natural science at Shorter College, Rome, Virginia, and in 1912 became associate professor (later professor) of biology at Richmond College, also situated in Virginia, where he remained until 1915. During 1916–17 he held an Austin teaching fellowship (zoology) at Harvard, but he spent most of this period as a private in the U.S. Army, being demobilized in 1919 as a second lieutenant in the Sanitary Corps. After the War, J. J. R. Macleod made him assistant professor of physiology (later associate professor) in the University of Toronto. He remained there until 1927,

when he went to the chair of physiology at the University of California, Berkeley. In 1931 he was appointed Senior Fellow to the Committee for the Relief of Belgium.

During his years as a Rhodes Scholar, Olmsted spent much of his time in France and became fluent in the language, and he also acquired an extensive knowledge of French literature and history. Being historically minded, it was natural that he should turn to historical writing in physiology ; this resulted in a number of excellent papers and in three notable biographies : Claude Bernard (1939), François Magendie (1944), Charles-Edouard Brown-Séquard (1946), all three of which may be regarded as definitive, since no comparable studies of these important contributors to physiology have appeared in any language. Olmsted's scientific interests were wide and ranged from the special senses, the subject of his five excellent chapters in Macleod's "Physiology and Biochemistry of Modern Medicine" (fifth edition, 1927), to other aspects of neurophysiology and to carbohydrate metabolism, an interest inspired originally by Macleod. He published two of the pioneer papers on the action of insulin from the Toronto group—one under his own name on the effects of temperature, and another with A. C. Taylor on the action of insulin on oxygen saturation—both of which were submitted in April 1924 and appeared in the *American Journal of Physiology* for June of that year (**69**, 137 and 142).

Known as 'Olmie' to his closest friends, James Olmsted was by nature well poised but retiring, gentle in manner, the soul of kindness to students, and a quiet and most effective teacher. He took relaxation in music and painting, his medium in the latter having been chiefly water-colour. He was a member of the San Francisco Art Association, with which body he often exhibited. In a very real sense he was a physiologist in the best humanistic traditions of Foster and Sherrington. JOHN F. FULTON

NEWS and VIEWS

Pharmaceutics in the University of London : Prof. H. Berry

Prof. H. Berry retires from his appointment as professor of pharmaceutics in the University of London and from his office as dean of the School of Pharmacy on September 30. He commenced his teaching career in 1919 after service in the Royal Fusiliers, Royal Engineers and Royal Garrison Artillery during the First World War. His first appointment was at the Robert Gordon's College, Aberdeen, but he soon transferred to the College of Technology, Birmingham, where he initiated and developed the Department of Pharmacy. In 1934 he joined the School of Pharmacy, University of London —then called the College of the Pharmaceutical Society—where he held a University readership in pharmaceutics and was appointed vice-dean. In 1937 he succeeded Prof. J. H. Burn as dean, and the title of professor of pharmaceutics in the University of London was conferred upon him in 1944.

It is in a large measure due to Prof. Berry's appreciation some twenty years ago of the impact of the advance of knowledge upon pharmacy that the new conception of pharmaceutics has been developed. He clearly saw that the day of empiricism was passing and that modern needs called for the application of science and engineering to the erstwhile pharmaceutical arts. Furthermore, he recognized that increasing costs and the development of the subjects of the degree to honours standards presented serious financial problems, and he succeeded in persuading the University of London and the University Grants Committee to accept the main burden of finance. This fundamental change was accompanied by a complete revision of the government of the School, which was consolidated when a Royal Charter was granted in April 1952. The new premises in Brunswick Square are, and will remain, a tribute to his work. His contributions to research have been mainly in the field of pharmaceutical microbiology, and many of the forty-five published papers will come to be regarded as classical contributions to the science. Prof. Berry, like all busy men, has found time to serve on many national and international committees, on the Pharmacopœia Commission and on the revision committee of the British Pharmaceutical Codex.

Prof. Edward Shotton

Dr. Edward Shotton has been appointed to the chair of pharmaceutics at the School of Pharmacy, University of London, in succession to Prof. H. Berry. Dr. Shotton is a senior lecturer in pharmaceutics and a recognized teacher of the University. He qualified as a pharmaceutical chemist from the College of Technology, Birmingham, in 1933 and was appointed in 1934 as demonstrator in the College of the Pharmaceutical Society. In 1939 he joined the research staff of Burroughs Wellcome and Co. at Dartford, and later was appointed head of the Development Laboratories. In 1939 he obtained a London B.Sc. (Special) with first-class honours in chemistry, and in 1955 was awarded the degree of doctor of philosophy for a thesis entitled "Interfacial Tensions between Benzene and Sols of Arabic Acid and its Salts". He is a member of the University of London Board of Studies in pharmacy, and of the Boards of Examiners for the Pharmaceutical Society and the Universities of London and Manchester.

Dr. Shotton has made valuable contributions to the re-organization of the programme of training in pharmaceutics for the B.Pharm. degree along the lines envisaged by Prof. Berry, dividing the subject into three parts : general pharmaceutics, pharmaceutical microbiology and pharmaceutical engineering science. It is confidently expected that Dr. Shotton's long experience as a teacher and his experience in the pharmaceutical industry will enable him to weld these three parts into a living entity, and that he will continue to develop the scientific aspects of his subject and maintain it in correlation with the progress of pharmaceutical industry. Dr. Shotton's research interests have included problems of sterilization, the entrainment of liquid during distillation, the interfacial tension of solutions of arabic acid, the physical properties of granules which may affect adherence on compression, the stability of emulsions and emulsifying power, problems of formulation, etc.

Nuclear Power at the Imperial College, London : Prof. J. M. Kay

THE University of London has announced the appointment of Dr. J. M. Kay to the newly instituted chair of nuclear power at the Imperial College of Science and Technology. This will provide a focus in the College for study and interest in the fundamentals of nuclear power and in the engineering techniques involved. It will operate through post-graduate courses and research, and will maintain close liaison with all the Departments of Engineering and with those of Physics and Chemistry. Dr. Kay, who is thirty-five, graduated in the University of Cambridge, where he later held a University demonstratorship in chemical engineering. In 1952 he was appointed chief technical engineer of the Industrial Group of the Department of Atomic Energy at Risley, Lancashire; since 1955 he has acted as a consultant in the field of nuclear power and in related industries.

University of Khartoum Bill

A BILL converting the University College of Khartoum into a University has been passed by both Houses of the Sudanese Parliament and submitted to the five Supreme Counsellors, in whom the presidential powers are vested, for their assent. The special relationship with the University of London, introduced in 1947, will cease, except in regard to students already registered, and the new University will award its own degrees and institute honours courses. Its budget for the next three years has been approved by the Sudanese Cabinet. When the Bill conferring university status comes into effect in the near future, Khartoum will be the first of the six overseas university colleges in special relationship with the University of London to assume university status. It will continue, however, to appoint external examiners from London as well as from other universities, and English will still be the language of instruction except in the Departments of Arabic and Sharia (Islamic) Law. The University will retain full autonomy, with executive powers vested in a council electing its own chairman and empowered to nominate a chancellor for appointment by the Supreme Council. Other Council members will include the vice-chancellor, treasurer, warden, members of the academic staff, nominees of Sudanese public and other bodies, and certain persons co-opted from the professions. The principal of the College, Prof. Michael Grant—on leave of absence from the chair of humanity in the University of Edinburgh—will become vice-chancellor. About three-quarters of the teaching staff are British, the remainder being mostly Sudanese (including three professors) and Egyptian. Appointments to twenty-four vacant posts have recently been offered. At the beginning of the new session there are expected to be 875 students in the University's seven faculties—an increase of about 170. It has developed from the former Gordon Memorial College, inaugurated in 1903 and extended to include the Higher Schools in various subjects (1945), and the Kitchener School of Medicine (1951), of which the final diploma is recognized by the Royal Colleges of Physicians and Surgeons.

Colonial Development Corporation

REPLYING for the Government in a debate on the Colonial Development Corporation in the House of Lords on June 20, Lord Lloyd, the Under-Secretary of State for the Colonies, said that there was no doubt that certain of the Corporation's activities, which the Secretary of State had been advised were *ultra vires* in relation to the Overseas Resources Development Act, 1948, were desirable from the point of view of the development of the Colonial territories. This legal opinion was disputed by the Corporation, and the Secretary of State for the Colonies accordingly proposed to introduce legislation to put the issue beyond legal doubt. A Bill had already been drafted, and the Government hoped to introduce such legislation before the end of the session. It was the Government's view that nothing should stand in the way of such legislation to validate actions which have been taken by the Corporation and are assumed to be *ultra vires*.

Atompraxis : New German Monthly Periodical on Atomic Energy

WITH the release at last year's Geneva Conference of much scientific and technical information concerning reactors and the peaceful uses of atomic energy, interest has been stimulated in many countries, and several new periodicals devoted to the study of individual branches of the subject have recently been launched. In Germany, where interest in nuclear science and engineering need no longer be purely academic, the new illustrated monthly periodical, *Atompraxis*, should prove most valuable in providing a medium for the dissemination and discussion of basic material and of new developments. The periodical is published by Verlag G. Braun, price DM 3.50 a number or DM 36 a year, and is obtainable in Britain through I. R. Maxwell and Co., Ltd., of London. The first number (pp. 40) contains articles on the use of radioactive isotopes in engineering, industry and hydraulics; safety and protection problems arising in reactor projects; the therapeutic use of the short-lived yttrium-90 isotope as a strong beta-emitter; fundamentals, practice and problems of sterilization and preservation by gamma radiation; and a review of the Geneva conference. One section is devoted to short summaries of important articles selected from other periodicals, and another to brief reports of the proceedings of conferences and society meetings. The editor, Dr. E. H. Graul, of Marburg, is assisted by Dr. K. Kaindl, of Linz, and Dr. A. Montens, of Essen.

Recent Donations to the Natural History Department of the Royal Scottish Museum, Edinburgh

DURING recent months the Natural History Department of the Royal Scottish Museum, Edinburgh, has been enriched by several important gifts. These include the large and important collection of cetacean remains formed by the late Sir William Turner, principal of the University of Edinburgh, which has been presented by the University; the large collection of bird-skins, numbering nearly eight thousand, mainly from North Africa and Sicily, formed by the late Joseph I. S. Whitaker and containing Lord Lilford's collection, presented by Miss D. Whitaker, of Rome; a small collection of bird-skins from Cyprus formed by Mr. G. F. Wilson, of the Cyprus Secretariat, presented by Mr. H. F. Zetter on behalf of the English School, Nicosia; the collection of bird eggs formed by the late Sir Maurice Denny and bequeathed by him to the Museum; the collection of British Crustacea formed by the late Thomas Scott, of the former Fishery Board for Scotland, presented by Dr. C. E. Lucas, of the Scottish Home

Department; and a collection of marine shells from the New Hebrides and New Caledonia, made and presented by Mrs. Georgina Mills.

Electronic Computer for the Meteorological Office

Approval has been given for the Meteorological Office to buy an electronic computer, and one has been ordered. The machine will be installed in the Napier Shaw Laboratory at the Central Forecast Office, Dunstable, and will be employed primarily on research into forecasting by numerical methods the space distribution of the height of selected isobaric surfaces which define the main features of the wind and temperature distribution up to some 10 km. above the Earth. On the basis of this information, the experienced forecaster can make the forecasts of wind and weather. Experience has shown the prediction of the future pattern of atmospheric structure to be one of the most difficult parts of forecasting; it is this part which electronic computers, by solving simplified forms of the dynamical equations of the atmosphere, can perform. Research into numerical forecasting has been conducted by the Forecast Research Division of the Meteorological Office for about eight years; but the Office has had to hire or borrow 'time' on the electronic computers belonging to others for actual trial of its methods. The computer will also be available for research into other complicated problems of meteorology, in which very heavy numerical work is involved.

Soaps as Polyelectrolytes

As a continuation of earlier seminars in the Chemistry Department of University College, London (*Nature*, **175**, 670; 1955), Prof. J. J. Hermans, of the University of Leyden, gave a lecture on April 30 on polyelectrolyte properties of soaps. Debye's work (*Ann. New York Acad. Sci.*, **51**, 575; 1949), dealing with the light-scattering of dilute soap solutions, was discussed, both the merits and the shortcomings of this treatment being demonstrated. Hutchinson's conclusions (*J. Colloid. Chem.*, **9**, 191; 1954) neglect the fact that the system under consideration contains two solute components. Trap and Hermans (*Kon. Ned. Akad. Wet. Amsterdam*, B, **58**, No. 2; 1955) carried out some accurate light-scattering measurements from which it follows that certain dilute soap solutions, in the presence of 0·05 *M* potassium chloride, contain rod-shaped micelles about 1000 A. long. This is consistent with earlier results of Debye and Anacker (*J. Phys. Coll. Chem.*, **55**, 644; 1951). In the discussion, Dr. G. S. Hartley mentioned that the possibility of rod-shaped soap micelles had been considered by him in 1939, and Dr. J. H. Schulman referred to his recent work on surface tension. Other participants in the discussion directed attention to peculiar observations during the passage of soap solution through membranes. Finally, the question was discussed as to whether the intrinsic viscosity of soap solutions, determined at sufficiently low rates of shear with a Couette instrument, in conjunction with light-scattering experiments, might be helpful in estimating the size and shape of soap micelles. Such an approach would appear to be of interest, because of its success in the fields of other polyelectrolytes.

Rearing Locusts in the Laboratory

Ever since the days of T. H. Huxley, the standard introduction to the study of insect anatomy has been the dissection of the cockroach. Although large and easily obtainable, the cockroach is not an ideal insect for this purpose; the locust is better suited for teaching and for practice in elementary dissection. During recent years the locust has also proved increasingly useful for experimental work of many different kinds. The ease with which locusts can be reared in classroom or laboratory is not generally realized; it is therefore timely that the Anti-Locust Research Centre (1 Princes Gate, Kensington, London, S.W.7) should have produced a pamphlet, "Instructions for Rearing and Breeding Locusts in the Laboratory", by P. Hunter-Jones (pp. 9; 1956), which will be useful for both research workers and teachers. The easiest species to rear is the African migratory locust, *Locusta migratoria*, and most space is devoted to this; but the special requirements of the desert locust *Schistocerca gregaria*, the red locust *Nomadacris* and the Egyptian grasshopper *Anacridium* are briefly outlined. Copies of the pamphlet are obtainable on request from the Centre, which is often prepared to assist by supplying day-old hoppers for starting locust stocks.

Griseofulvin and Pathogenic Fungi

R. S. C. Aytoun has contributed some interesting information on the effects of griseofulvin on actively growing hyphae of phytopathogenic species of *Botrytis*, *in vitro* and *in vivo* (*Ann. Bot.*, N.S., 20, 78, 297; 1956). *In vitro*, the reactions noted were slowing of the growth-rate, stimulation of branching, abnormal appearance of hyphal protoplasm, and loss of rigidity of the hyphal membrane in the region of the tip. The antibiotic is not translocated within the mycelium. *In vivo*, *Botrytis tulipae* was incapable of penetrating cell membranes in the stem of tulips watered with griseofulvin. The antibiotic was shown to delay or to prohibit the penetration of onion epithelium by *B. allii*, depending on concentration. The characteristic curling and stunting of hyphae caused by griseofulvin have both been observed to occur in plant cells.

Forestry Commission: Report for 1953–54

The annual report of the Forestry Commission for the year ending March 1954 (pp. 177+8 plates. London: H.M.S.O., 1955; 6*s*. net) contains an introduction by Mr. James Macdonald, director of research and education, outlining the three sections in which forestry research is considered in the report. The first section deals with brief summaries of the main trend of work proceeding in the Research Branch of the Commission; the second deals with projects under investigation by universities and other institutions; and the third, a new section, comprises a series of papers by members of the research staff on subjects which have yielded sufficient information to be made public in this form, although often the importance of the inquiry must be considered as provisional. This is a most useful departure; so often during a piece of research work being undertaken a point is reached at which it would be useful for both the research worker and others to know exactly how far the investigation has gone, and yet this cannot be made available in a research report since the knowledge available is not of sufficient detail. A list is added to the report of the more important experimental areas in Great Britain, classified under subjects. As the report shows, contact has been maintained with universities and institutions engaged on research in forestry and related subjects, such as the Rothamsted Experi-

mental Station and the Macaulay Institute for Soil Research. The Nature Conservancy, which is concerned with woodlands, has also been of great assistance. In order to secure liaison in fields of common interest, a small informal committee of representatives of the Nature Conservancy and the Forestry Commission has been established to discuss matters of research and investigation. The Research Branch of the Commission also takes an active part in the affairs of the International Union of Forest Research Organizations.

Rhizomorph Behaviour in *Armillaria*

S. D. GARRETT has investigated some of the factors which determine the vigour of the infection of potato tubers by the rhizomorphs of *Armillaria mellea* (*Ann. Bot.*, N.S., **20**, 78, 194; 1956). The growth of rhizomorphs of *Armillaria mellea* from small woody inocula through tubes of soil was characterized by a progressive decline in weekly growth increments. The initial growth-rate was related to the size of the inoculum food-base; the subsequent decline is attributed partly to depletion of nutrient reserves in the inoculum through fungal respiration and growth, and partly to competition for nutrients between the main growing apex of the rhizomorph and its subordinate branch apices. The vigour of infection of potato tubers by rhizomorphs from such small woody inocula increased with size of the inoculum, and decreased with increasing distance between inoculum and tuber. When the inoculum potential of *A. mellea* was low, the fungus was generally overtaken in the tuber tissues by soft-rotting bacteria, which prevented its further advance.

Zoological Nomenclature

As from November 9, 1956, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details have already been published (*Bull. Zool. Nom.*, 11, Pt. 11, 1956). (1) *Turbinella* Lamarck, 1799 (Cl. Pelecypoda), validation; (2) *Terrakea* Booker (F. W.), 1930, designation of type species for, and *brachythaerus* Morris, 1845 (*Productus*), validation of (Cl. Brachiopoda); (3) *Unio* Philipsson, 1788 (Cl. Pelecypoda), designation of type species for; (4) *Elaphe* Fitzinger, 1833 (Cl. Reptilia), validation; (5) *daea* Dampf, 1910 (*Palaeopsylla*) (Cl. Insecta), determination; (6) *Torquesia* Douvillé, 1929 (Cl. Gastropoda), designation of type species for; (7) Horniman (R. B.), January 1940, "Preliminary Descriptions of some new Birds", suppression. Comments should be sent as soon as possible to the secretary to the Commission, Mr. Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Equal-Loudness Contours for Pure Tones

THE equal-loudness contours for pure tones heard binaurally have been redetermined at the Acoustics Section of the National Physical Laboratory, Teddington, by D. W. Robinson and R. S. Dadson (*Brit. J. App. Phys.*, **7**, 166; May 1956). Loudness is one of the few concepts which can be correlated with several aspects of the complicated subjective reaction to a sound and therefore provides a starting-point for measurement in such work. The relation between the loudness of a sound and its root-mean-square pressure and frequency for various waveforms and for binaural and monaural hearing is of interest not only in the understanding of the hearing mechanism and its reaction to pure and complex sounds, but also in the design of frequency-weighting circuits for such instruments as the 'sound-level meter' and in the calculation of loudness-levels from the spectrum analysis of sounds. Discrepancies exist between the previously published pure tone equal-loudness contours for free-field conditions (Fletcher, H., and Munson, W. A., *J. Acous. Soc. Amer.*, **5**, 82 (1933), and Churcher, B. G., and King, A. J., *J. Inst. Elec. Eng.*, **81**, 57 (1937)), and it was not possible to derive an acceptable standard. The new work reported by the National Physical Laboratory, which covers increased ranges of frequency and sound pressure and the effect of age and sex of otologically normal subjects, is a welcome redetermination. Although these results differ by up to 10 phons from the previous determinations, they are more regular with sound pressure and frequency, and the errors are estimated to be only about ± 1 phon over the greater part of the work.

Royal Commission for the Exhibition of 1851: Awards for 1955

THE Royal Commission for the Exhibition of 1851 has awarded the following senior studentships for 1956 for research at the universities indicated: C. M. P. Johnson (Cambridge), nuclear physics at Cambridge; C. B. Reese (Cambridge), organic chemistry at Cambridge; Dr. M. W. Windsor (Cambridge), physical chemistry at Sheffield; A. J. Smith (Wales), geology at the University College of Wales, Aberystwyth. The Commission has also awarded the following overseas scholarships for 1956: Canada: C. B. M. Bailey (British Columbia), animal growth; C. Crowe (Western Ontario), physics at Cambridge. Australia: Dr. (Miss) B. I. H. Hall (Adelaide), physics at University College, London; A. L. Hunt (Adelaide), biochemistry at Oxford; S. P. H. Mandel (Sydney), mathematics at Cambridge; D. A. Levy (Sydney), theoretical chemistry at Cambridge. New Zealand: G. G. Pritchard (New Zealand), botany at Cambridge; W. D. Twose (New Zealand), physics at Cambridge. India: Dr. J. Jacob (Annamalai), zoology at Queen's College, Dundee, University of St. Andrews. Pakistan: F. Aziz (Lahore), radiochemistry at Cambridge.

University of Nottingham: Gifts

THE following gifts have been received by the University of Nottingham: £2,000 a year for five years from Imperial Chemical Industries, Ltd., towards the cost of building up a school of colloid science in the Physical Chemistry Laboratory; a research scholarship of £600 a year from W. Canning and Co., Ltd., of Birmingham, to be held in the Department of Metallurgy, for research in the field of metal finishing; £300 a year for three years from the Electro-Chemical Engineering Co., Ltd., of Woking, to the Department of Metallurgy towards the cost of a scholarship for research in metal finishing.

Physics of Nuclear Reactors

A CONFERENCE on "The Physics of Nuclear Reactors" arranged by the Institute of Physics was held in the Institution of Electrical Engineers during July 3–6. The programme opened with an address by Sir John Cockcroft, president of the Institute, on "Scientific Problems in the Development of Nuclear

Power". This was followed by lectures on the physics of advanced reactors, the zero-energy fast breeder reactor, effects of irradiation on the physical properties of solids, shielding, control, instrumentation, chemistry and metallurgy in a nuclear energy project, and the uses of reactors; Prof. R. E. Peierls gave an evening discourse on "Recent Developments in Nuclear Theory". Speakers came from Britain, the United States and Canada. An informal dinner was arranged for overseas visitors, who were also entertained at a Government reception. During the meeting there was an exhibition of books and of apparatus. The lectures, with the exception of that by Prof. Peierls, will be published as a supplement to the *British Journal of Applied Physics*; the programme of the conference includes full abstracts of the lectures.

Commonwealth–American Universities Conference

The Commonwealth–American Universities Conference, at which university presidents from the United States representing the Association of American Universities will participate with vice-chancellors of United Kingdom and Commonwealth Universities, will be held this year in London and Birmingham during July 10–17 under the auspices of the Association of Universities of the British Commonwealth. The sessions in London will be opened by a reception on the evening of July 10 in the Senate House of the University of London at which H.M. the Queen Mother will be present as Chancellor of the University. Discussions will be held in London on the general question of "University Expansion in relation to Population Trends", with particular emphasis on the effect of the approaching 'bulge' in the university age-group in the United States and in various countries of the Commonwealth. The members of the Conference will visit Exeter on July 13 for the ceremony of installation of Mary, Duchess of Devonshire, as first chancellor of the new University. On the following day members will meet in Birmingham, where discussions will be held on a series of problems common to universities in Britain and the United States, such as the adequacy of school preparation for college and university students, the need for an expanding curriculum to meet new world needs, and the relationships of university administration to students, faculties and governing boards.

Royal Meteorological Society: Officers for 1956–7

The following have been elected officers of the Royal Meteorological Society for the year 1956–57: *President*, Dr. R. C. Sutcliffe; *Vice-Presidents*, Prof. G. Manley, Sir Graham Sutton, R. G. Veryard and Dr. T. W. Wormell; *Vice-President for Canada*, Dr. D. P. McIntyre; *Vice-President for Scotland*, J. R. Atkinson; *Treasurer*, Dr. J. S. Farquharson; *Secretaries*, P. J. Meade, Dr. H. L. Penman, Dr. A. G. Forsdyke (*Librarian*) and Dr. G. D. Robinson (*Editor*).

Announcements

The gold Albert Medal of the Royal Society of Arts has been awarded for 1956 to Sir Henry Dale, "for eminent service to science, particularly physiology".

At the annual general meeting of the Marine Biological Association of the United Kingdom, held on June 27, Mr. E. H. E. Havelock, Dr. A. G. Huntsman and Dr. A. C. Redfield were elected honorary members of the Association.

The Council of the Royal Society has awarded the Tropical Research Fellowship (Medical Sciences) to Dr. D. G. Jamison, of Corpus Christi College, Oxford, for his work on the histopathology of leprosy with particular reference to the relationship of the mycobacteria to cutaneous nerve fibres.

Dame Caroline Haslett is resigning from the post of director of the Electrical Association for Women, which she has held since its inception thirty-two years ago.

Dr. Gerard Klein, lecturer in theoretical physics in the Royal Holloway College, London, has been appointed senior lecturer in mathematics in the Royal Technical College, Glasgow.

The following have been appointed to lectureships in The Queen's University of Belfast: L. J. Symons (geography), Dr. F. A. Lewis (inorganic chemistry) and R. Taggart (mechanical engineering).

The following have been appointed to lectureships in the University of Birmingham: Dr. J. G. Valatin (mathematical physics), Dr. G. A. Doran and Dr. P. M. Rolph (physics), Dr. L. W. Poel (botany), Dr. G. T. Wright (electrical engineering) and Dr. J. J. Pick (industrial metallurgy).

The British Iron and Steel Research Association will hold two 'open days' at its Sheffield Laboratories on September 6 and 7, for representatives of member firms.

The United Nations Food and Agriculture Organization is holding an international meeting of inland fisheries workers in Helsinki during July 24–26, at which inland fisheries in relation to world food economy will be reviewed. The European member nations of the Organization will be sending representatives and, at the same time, biologists at the Thirteenth International Limnological Congress, which is being held in Helsinki during July 27–August 7, have also been invited to attend as observers.

A residential course on rural studies, organized by the Institute of Rural Life at Home and Overseas, will be held at the Essex Institute of Agriculture, Writtle, near Chelmsford, Essex, during September 2–15. The course will be of a general nature, but tropical conditions will be included and the course should appeal to workers and students from overseas. The fee is £14. Application should be made not later than July 27 to the Secretary of the Institute, 59 Bryanston Street, Marble Arch, London, W.1, from whom further information can be obtained.

A symposium on "Recent Studies in Yeast and their Significance for Industry", arranged jointly by the Dublin Section and the Food and Microbiology Groups of the Society of Chemical Industry, will be held in Dublin at the Rupert Guinness Hall during September 17–18 (and possibly 19). The Biochemical Society, which is meeting in Dublin during September 14–16, is arranging sightseeing tours for the afternoon of September 15 and for the whole of the succeeding day; members attending the symposium can join these tours. Further information can be obtained from the honorary secretary of the Dublin Section of the Society of Chemical Industry, Dr. A. K. Mills, Arthur Guinness Son and Co. (Dublin), Ltd., Chemists' Laboratories, St. James's Gate, Dublin.

THE H. H. WILLS PHYSICAL LABORATORY

UNIVERSITY OF BRISTOL

DURING March 26–28 the Physics Department of the University of Bristol entertained several hundred guests with the object of showing both the teaching and the research work of the Laboratory to them. The guests included the Lord Mayor and Lady Mayoress of Bristol, professors of physics from other universities, industrial and government scientists, schoolmasters, and members of the academic staff of other departments of the University.

Apart from the numerous scientific conferences held in Bristol, including the British Association which met there last year, the Laboratory has not been on display in this way since its opening in 1927. The L-shaped building came into existence through the generosity of Henry Herbert Wills, and was designed by Sir George Oatley with the advice of Prof. A. M. Tyndall. Built on the hill where the old Royal Fort once stood, its extremely solid structure and embattled top well preserve the tradition of its name. It was originally intended to be only the first instalment of a group of University buildings, and with this in mind the north-western end was left unfaced, as it remains to-day. Grave doubts were, however, expressed at the time as to the wisdom of constructing so large a building with its two large lecture theatres, several smaller lecture rooms, library, workshops and research rooms, and all with ample provision for expansion. Three years after its opening the teaching and research staff numbered only eighteen, and many of the rooms were unoccupied. To-day, the staff number no less than seventy, and space is at a premium. Many research rooms have had galleries put in them (easily done because of the very generous ceiling heights) and special huts have been built to house both working low-temperature equipment and the mass of discarded apparatus characteristic of physics laboratories, which the occupants are not very likely to use again, but cannot bear to dispose of.

Throughout its existence, the Laboratory has been notable for the wide range of interest of its schools of research, and important contributions have been made in such different fields as magnetism, the electrical conductivity of gases, including accurate measurements of the mobility of gaseous ions, the spectroscopy of metals, the emission of soft X-rays, X-ray studies of long-chain hydrocarbons, and low temperatures. The result has been the development of a correspondingly wide range of experimental techniques and resources, and the work in progress to-day shows no less diversity. Most of the current research work, except that in theoretical physics, was displayed either by demonstrations of the working of the actual apparatus or by photographs and diagrams.

In optics, the interest is centred on high-aperture systems and interferometers for testing. A reflexion microscope of N.A. 0·95 (dry) and a meniscus Schmidt meteor camera of focal ratio $f./0·78$ and field diameter 36° were shown, both these instruments having already attracted considerable interest outside the Laboratory. The Laboratory also houses a commercial electron microscope which is available to all departments of the University, and is occasionally used also for work on problems encountered by local industries.

The early work of the Laboratory on low temperatures has already been mentioned, and the group engaged on this study is now one of the largest in the Department. Liquid oxygen and helium are purchased in bulk, and the Laboratory also has its own apparatus for producing liquid hydrogen and helium. The main subjects at present studied are paramagnetism of crystals at low temperatures, the superconductivity and thermodynamic properties of metals, the mechanical properties of solid argon, and properties of the liquid helium film.

The Department is well known for its work, both theoretical and experimental, on the solid state, and this interest was manifested in the exhibits of several different groups. Work on the growth of both metallic and non-metallic crystals was shown, and also on the structure of macromolecular substances such as polythene and nylon. Techniques for handling single crystals of silver halides have also resulted in the elucidation of many problems connected with photographic materials, and have also enabled the dislocation structure of a solid to be studied in a particularly direct manner.

The crystalline structure of thin evaporated metal films has been studied by X-ray techniques, and the effect of conditions of deposition and adsorbed gases on the electrical properties of these films has also been the subject of considerable experimental investigation. The mechanical properties of metals, particularly the mechanism of the development of fatigue cracks, and the investigation of the creep of strained single crystals, constitute the work of another group, the aim in this case being to produce results capable of theoretical interpretation rather than of immediate technical use.

Techniques for the electronic measurement of very small strains were also in evidence in work on ferroelectrics, in which hysteresis loops not only of polarization against field but also of mechanical strain against either could be displayed oscillographically. Attempts are also being made to produce an 'artificial' dielectric material of extremely high permittivity. In all these solid-state studies the Laboratory is fortunate in being well equipped with X-ray diffraction apparatus, including single-crystal and powder cameras, a stabilized X-ray unit with an output constant to better than 1 per cent, and a Geiger-counter diffractometer for X-ray fluoroscopy.

A comparatively recently developed interest in the Department is the study of mineral separation, which centres mainly on the flow properties of fine sands or slimes suspended in water. Apparatus for bulk separation has been devised, and also an analytical tool, the 'mechanized vanning shovel', which reproduces some of the movements used by Cornish miners in assessing the separable mineral content of ores.

The largest research group, and probably the best known, is devoted to the study of cosmic rays and is housed at the top of the building. The two most important techniques demonstrated were the production and flying of high-altitude balloons, and the processing and examination of nuclear emulsions, both of which have been greatly advanced as a

result of work by the Bristol group. The importance of this work both in the study of the nature of cosmic-ray primaries, and in the investigation of nuclear events at energies higher than can be obtained even with the largest accelerators, is too well known to require elaboration here.

The more routine activities of the Laboratory, such as in the teaching laboratories, workshop and glass shop, were on view and excited considerable interest, and in these matters the Department can congratulate itself on being very well staffed and equipped. As a further diversion to visitors, films were exhibited periodically in the large lecture theatre. These films were made by members of the Laboratory and illustrated work on cosmic rays, glass blowing and crystal growth.

For its growth from small beginnings to its present state, the Laboratory owes an enormous debt of gratitude to Prof. A. M. Tyndall, first holder of the Henry Overton Wills chair of physics (1919–48). In this office he was succeeded by Prof. N. F. Mott (1948–54) and then by Prof. M. H. L. Pryce (1954–). The second professorship, the Melville Wills chair, has been held by the late Sir J. E. Lennard-Jones (1927–32) and Prof. N. F. Mott (1933–48), and the present incumbent is Prof. C. F. Powell (1948–). From time to time a third professor of physics has been appointed—Prof. S. H. Piper (1951–53) and Prof. F. C. Frank (1954–). A recent addition to the distinctions of the academic staff was the election this year of Dr. J. W. Mitchell to the fellowship of the Royal Society.

Comments and letters received from the visitors by the organizers seemed to confirm that the open days, although involving a considerable amount of work, have been successful in bringing the activities of the Laboratory to the attention of its guests in an interesting and agreeable way. D. F. Gibbs

CARNEGIE INSTITUTION OF WASHINGTON

REPORT FOR 1954–55

YEARBOOK No. 54 of the Carnegie Institution of Washington* covers the year July 1, 1954–June 30, 1955, including Dr. Vannevar Bush's final report as president and the reports of departmental activities and co-operative studies, with a bibliography of publications of the Institution and of the president in addition to those appended to the departmental reports. At the Mount Wilson and Palomar Observatories two major studies of the Andromeda nebula were completed during the year: an intensive study of the high-luminosity variables, including the cepheid, the long-period, the semi-regular and the irregular types; and a systematic search for novæ during two observing seasons, in which the detailed light curves of thirty novæ were measured and, for the first time, definitive statistical information was obtained on the absolute luminosities at maximum, types of light curve and the frequency of these novæ. A third major project was the establishment of a precise, photoelectrically determined magnitude-scale, extending down to the faintest observable stars in several areas distributed in such a way that at least one of the areas is always visible in the night sky for comparison. The project has now provided standards for use throughout the range of the Hale telescope. The programme concerned with setting up photoelectric standard-magnitude sequences has also been completed, and the study of the internal motions in planetary nebulæ continued, as well as spectroscopic observations of the Cassiopeia radio source and a spectroscopic observation of the colliding pair *NGC* 1275 in the Perseus cluster of galaxies. A new grating spectrograph was put into service at the Cassegrain focus of the 60-in. telescope, and a new stellar template magnetometer is being developed to increase the efficiency of observations of stellar magnetic fields, depending on the use of a template of the spectrum of the star to be investigated.

The Joint Committee on Image Tubes for Telescopes is attempting to develop a promising type of image converter for mass production, in which a very thin film is stretched across the end where the phosphorescent screen would otherwise be located; this film permits the electronic image to be formed astride the tube while the high-quality vacuum is preserved. An attempt is also being made to develop a special type of thin-film converter capable of withstanding full atmospheric pressure, thus avoiding the complications of the vacuum charger required in the first converter.

The Department of Terrestrial Magnetism, using the 'Mills cross' array of antennæ, has made the interesting and unexpected discovery of a variable 22-Mc./s. source of small dimensions in the constellation Taurus. A comprehensive series of measurements on the distribution of hydrogen clouds in several sectors of our galaxy indicates that our solar system is near the inner edge of a local arm, and that this arm is not circular about the centre of the galaxy but is strongly inclined. Observations have also been made on the intensity distribution of the emission from the 'quiet' Sun and on the low-frequency radio emission from several of the most intense sources in the sky, with the view of differentiating between thermal and other possible mechanisms producing these radiations. In a seismic expedition to the Rocky Mountains in the summer of 1954, unequivocal evidence was obtained that the sharp boundary between the crust and mantle of the Earth lies at the same depth under the Colorado Plateau in Arizona and New Mexico as under the coastal plain in Maryland and Virginia, and later in the summer the same result was obtained under the mountains of Utah. Encouraging progress was made in determining the extent to which the history of the changes in the Earth's magnetic field can be traced in geological time, and an expedition to Arizona and New Mexico showed that the rocks of the south-west of the United States give about the same location for the magnetic pole in Permian time as is indicated by the rocks of Great Britain. In the programme of isotope dating for ancient minerals, age studies of minerals in the Quartz Creek (Colorado) area have demonstrated a pattern of consistency among the rubidium–strontium ages and also among the potassium–argon ages of the micas from this region. Studies have also been made of toroidal magnetic fields in the ionosphere, of the daytime enhancement of the initial phase of magnetic storms at Huancayo, and the investigation of nuclear energy-levels by the

* Carnegie Institution of Washington. Year Book No. 54 (July 1, 1954–June 30, 1955), with Administrative Reports through December 9, 1955. Pp. xxxix+9+311+3 plates. (Washington, D.C.: Carnegie Institution of Washington, 1956.) Cloth, 1.50 dollars; paper, 1 dollar.

method of Coulomb excitation with alpha-particles was continued.

A major shift in biophysical work was made from the study of the synthesis by cells of small units like amino-acids to the organization of these units into the biologically active molecules of protein and nucleic acid. The kinetics of protein formation in bacteria and yeast have been studied and the specific adsorption of amino-acids as a first step in their incorporation into proteins observed, while experiments have also been made on the role of peptides in protein synthesis.

The Geophysical Laboratory has completed a broad study of the system copper–iron–sulphur and has discovered a strong dependence of (solid state) inversion temperatures on very slight excesses of silver or tellurium in the compounds Ag_2Te and Ag_3Te_2. Extensive X-ray studies of single crystals of digenite have been completed, and preliminary experiments made on methods of dissolving sulphide ores *in situ*. In the hydrothermal synthesis of albite, small but significant variations in lattice parameters have been discovered as a function of temperature of crystallization alone. In statistical petrography the emphasis has been primarily on the theory and technique of modal analysis, while a systematic investigation has been made of the effect of cæsium and thallium on the system $K_2O.Al_2O_3.6SiO_2$—H_2O, using special radioactive tracer techniques with the view of obtaining the fundamental data needed on the distribution of trace elements. Much attention has been given to all three amphibole groups as well as to feldspars and micas.

The Department of Plant Biology has further developed a new way of measuring the absorption of light of different colours by the functional pigments in living plant material and in solutions of the extracted pigments, and the method has already been utilized in studying the photochemistry of chlorophyll. Progress is being made in the isolation of the protochlorophyll holochrome in increasingly smaller units. Experiments on the transformation of protochlorophyll to chlorophyll have continued in aqueous and glycerol extracts of various etiolated plants, all the extracts so far prepared showing particles in a dark-field microscope. Studies of the rate of re-formation of protochlorophyll in leaves illuminated and then returned to darkness have shown that the rate of re-formation accounts for the rate of formation of chlorophyll in illuminated plants for the first two hours. Investigations in etiolated barley seedlings of the precursors of protochlorophyll which contain magnesium have indicated that the extra magnesium accumulated in illuminated plants is contained in an acidic fraction and that from one-third to two-thirds of the total protochlorophyll in barley is of the phytol-free form. The range-grass programme has continued, and the chromosome numbers of all but one of the hybrid *Poa* lines used in the regional tests are now known. The study of the biosystematic structure of the aquatic plant family Lemnaceae has continued, and experiments in general taxonomy have been designed to elucidate the complex genetic and environmental relations between and within wild species of plants. A new planting of the second generation of yarrow from coastal and alpine environments is providing information about the hereditary constitution of the parental races. Studies on the rate of growth under laboratory conditions of different species and strains of the miniature *Lemna* have indicated little difference in the optimum temperature for growth between strains of the same species from different climatic regions, the differences being between species rather than between races of the same species. This lack of distinct racial differences within the species is strikingly at variance with the findings in species of other plants grown in soil.

The report of the Department of Embryology includes a brief survey of the work of the Department during 1913–55 whereby the description of the human embryo has now been completed by the definitive description of those representing the first four or five days of development. A comprehensive investigation of the development of the human diaphragm has clarified the anatomical defects underlying diaphragmatic hernia. Studies continued of the uterine lining, especially of its blood vessels, in relation to the phenomena of menstruation, and a preliminary account has been published of work on the passage of the sugars across the monkey placenta, using a method which promises to be very useful in studying fœtal physiology.

In the Department of Genetics electron-microscope studies of third-instar salivary-gland cells of *Drosophila* have afforded evidence of the polytone nature of the chromosomes, the subsidiary strands having a diameter of about 500 A. and being arranged in a hierarchical assembly of intertwined pairs of pairs. Investigations of the action of cytochrome *c* in reducing basophilia of tissue sections indicate that basicity *per se* is not the determining factor since lysozyme, another basic protein, does not reduce basophilia of tissue sections, whereas hæmoglobin, another hæmoprotein, does. All three proteins increase staining with acidic dyes. Although a considerable degree of purification of calf-spleen deoxyribonuclease has been effected, crystallization has not yet been achieved, and the marked changes in the mode of action with purification suggest that several enzymes capable of degrading deoxyribonucleic acid may be present.

Chemical studies of bacteriophage have provided further evidence of the genetic role of viral nucleic acid. The substance that initiates viral infection is at least 95 per cent pure nucleic acid, and this increases in infected cells before viral-precursor protein begins to form. Substances such as chloramphenicol that inhibit protein synthesis do not interfere with the formation of nucleic acid, and nucleic acid 'purified' in this way behaves like normal virus precursor. Accordingly, nucleic acid is not synthesized inside a viral membrane and can function without associated protein. New evidence has been obtained that, in the transduction of *Salmonella* clones, incorporation of the genetic specificity of the donor strain into the genotype of the recipient usually occurs in the single daughter cells within one or two divisions after infection. Genetical analysis of short regions of the chromosome complex of *Salmonella typhimurium* have shown that all the known tryptophan, cystine and methionine loci are closely linked. A high concentration of amino-acids during the critical period corresponding to the first third of the first division after irradiation appears to be a major requirement for the production of induced mutants, and evidence has been obtained in the transformation of genetic markers in *Salmonella* that mutations are frequently induced during the preparation of the donor material. Other work on controlled mutation in maize and the organization of cellular materials is reported in some detail.

ITALIAN SOCIETY FOR GEOPHYSICS AND METEOROLOGY

FOURTH GENERAL ASSEMBLY

THE fourth General Assembly of the Società Italiana di Geofisica e Meteorologia (Genova) was held at the University of Genoa during April 5–8. The convention was opened by the president, Prof. M. Bossolasco, who welcomed the delegates to the Assembly. A large number of papers ranging over a wide number of topics was presented.

Prof. A. Defant (Innsbruck) delivered the opening lecture, on "Recent Developments in the Theory of Ocean Currents". Referring to the classical theory due to V. Ekman for a homogeneous ocean, he gave an account of the recent contribution due to H. Stommel and W. Munk, pointing out the objections directed to it and its limitation. He then discussed the theory of ocean currents due to G. Neumann, which uses as surface of reference that deduced for the Atlantic from the observations of the expedition *Meteor*. Prof. Defant showed that this new theory gives a possible explanation of the intensification of ocean currents on their west coasts. Reference was also made to some work by Charney on the formation of narrow currents on these coasts.

Prof. Perri (Turin) spoke on "The Slow Surface Wave and its Seismological Significance in a Limiting Case". This referred to a slow surface which was discovered by the author, the theory of which he developed in 1954. Prof. Perri recalled its main features and attributed the fact that the velocity of the wave is intermediate between that of the Rayleigh waves and Love waves to an abnormal dispersion.

Prof. A. Giao (Paris) presented a paper on "The Behaviour of the Advection Vector of the Perturbations of the Vertical Vorticity in the Free Atmosphere". After discussing the definition of the advection vector, Prof. Giao went on to consider applications to the atmosphere. By means of the observed temperature fields and wind between the equator and the poles (from sea-level to the 20-km. level) one can deduce the mean field of the advection vector of the perturbations and compare it with the mean wind in the field. This leads to the explanation of many empirical facts and gives the limits of the region of 'long waves'. The second part of the paper dealt with the derivation of a generalized equation for the vertical vorticity by a simple transformation of the equation of pressure variation in Prof. Giao's theory of perturbation.

"The Oscillations of the Natural Radioactivity of the Air in the Northern Alps, and Their Significance" was the title of a paper by Dr. R. Reiter (Munich). Dr. Reiter has found from many measurements of the air of the Zugspitze (2,600 m. above sea-level) that the greatest radioactivity is associated with southerly currents. This is considered to point to a dependence on the nature of the geological formations traversed by these winds, the formations containing granite and orthogneiss. Dr. Reiter also discussed the variations of the radioactivity of the air as a function of other meteorological factors.

A paper by Dr. C. Mennella (Naples) dealt with "The Reliability of the Presumed Normal Values of the Rainfall in Italy". Considering various series of rainfall measurements for the past hundred years or so, Dr. Mennella attempted to appraise the reliability of the mean values relative to quinquennial, decennial and longer periods. This enables one to estimate the degree of variability and instability and to deduce to what extent they are inadequate to represent the specific characteristics of the phenomena.

Dr. W. Hesse (Leipzig) spoke on "The Hydrogenic Balance of Plants" and on "The Results of Measurements made on Various Plants as Functions of Meteorological Factors". Dr. Hesse pointed out that the water system of cultivated plants is very complicated and is influenced by various external factors; on the meteorological side, several methods have been evolved to assess evaporation and transpiration of plants. In the vegetation period 1950, 1953, 1954 and 1955, Dr. Hesse used the newly developed Klein lysimeter in Leipzig, and from 1954 onwards a transpirograph and a measuring apparatus consisting of six different Klein lysimeters with which it was possible to assess the water content of plants.

Prof. O. Burkard (Graz) proposed a formula for the moving ionization of the F_2 layer in Europe. He showed that the squares of the critical frequencies $(f_0F_2)^2$ measured at European stations in the morning may be represented by the empirical formula:

$$(f_0F_2)^2 = K\left(\frac{\cos\chi}{\cos^2\varphi}\right)^x \cos^2\varphi$$

where χ is the zenith angle of the Sun, φ the geographical latitude of the station, x depends on locality, K is a constant depending on the locality and probably on the intensity of the solar ionizing radiation.

The communications from Prof. P. G. Piccardi and Dr. R. Cini (Florence) were presented by Prof. Bossolasco. These related to "The Action of an Electromagnetic Field of Frequency 10 kHz. on a Chemical Test" and "The Problem of the Influence of Atmospherics". Experiments showed that Prof. Piccardi's chemical test is influenced by an electromagnetic field of frequency 10 kHz. (kc./s.) and that it is probable that the variations observed during this test are due to variation in solar electromagnetic radiation as well as atmospherics due to lightning discharges.

Prof. V. Ferraro (London) gave an account of the present state of theories of magnetic storms. He pointed out that an atmospheric-current theory such as has been proposed by Vestine is unlikely to prove correct since on this theory it seems difficult to account for such distinctive phenomena as sudden commencements, auroral zones and other features which point rather to an influx of solar corpuscular streams in the upper atmosphere as the cause of these phenomena.

Dr. K. Rawer (Neuershausen b. Freiburg) gave an introductory talk to the general discussion on the International Geophysical Year. Dr. Rawer discussed in particular preparations made for the study of ionospheric recordings, absorption, 'winds', back scatter and whistlers. The discussion that followed related particularly to questions of interest to the Italian participants of the International Geophysical Year.

In a paper on "The Harmonic and Anharmonic Constants for the Tides at Palermo, Milazzo, Lipari and Cagliari", Dr. S. Polli (Trieste) said these are determined for periods of 26 months in the case of Palermo, and shorter periods for the other stations, by using the British Admiralty method developed by Doodson. The monthly and seasonal variations in

the tides are determined separately, so as to examine any seasonal variations of the constants. A second paper dealt with wind-bores in the ports of Trieste and Venice; it appears that this wind-bore traverses the gulf of Venice without change of direction, lateral expansion and with little loss of speed.

Prof. H. Berg (Cologne) dealt first with "The Velocity Profile in Rivers"—an attempt to express the vertical velocity gradient of rivers by a logarithmic law using certain ideas of Prandt concerning turbulent flow over rough surfaces. In a second paper, on "Examples of Trivial Correlations in Solar Terrestrial Relationships", Prof. Berg examined two such examples: Farthing's experiment, which led him to conclude that a period of intense coronal radiation is followed by a penetration of cold air over the Earth; and an investigation by Abbott, who claimed that the solar constant is considerably lowered on days of intense geomagnetic storms. Prof. Berg showed that the results in both cases are only the outcome of faulty mathematical reasoning.

Prof. G. Berbesconi (Genoa) considered the "Partial and Total Representation of an Ellipsoid on the Sphere". Starting from the principle of the minimum energy of deformation of an elastic ellipsoidal geographical network, Prof. Berbesconi determines a relationship between the ellipsoid of gyration and the local spherical surface in the neighbourhood of the oscillation point up to a radius of 250 km. He next examines various functions the extremals of which give a good representation of the whole ellipsoid on the sphere and define a new latitude which he considers useful for the construction of geographical globes.

Dr. I. Dagnino (Genoa) considered the "Frequency of Cyclones and the Distribution of Cloud in the Mediterranean", using the synoptic charts for all the days during the period 1946–55. For the case of the region of maximum frequency, Dr. Dagnino has examined and discussed the principal atmospheric and meteorological factors giving rise to these cyclones—in addition to the seasonal factors.

Prof. Bossolasco (Genoa) spoke on some work he has done with collaborators on "The Atmospheric Electric Potential in the Layers close to the Ground". The result of a series of observations (with Drs. Dagnino and Romagnone) to determine the variation of the atmospheric electric field near ground-level showed a decrease of the potential gradient from a height of 1 m. to 2 m., and a further decrease at a height of 3 m. The variation at discrete potential-levels confirms electrically the presence of a boundary layer near the ground. A second communication dealt with the "Measurement and Continuous Recording of the Salinity of the Atmosphere". The apparatus used for the purpose is one developed by F. Meda, based on the principle of collecting the radioactivity by passing the air through water.

Prof. M. Cutolo (Naples) spoke on "The Measurement and Behaviour of the Geomagnetic Field at the Lower Border of the *E*-layer". He described how this can be effected by taking the mean of the frequencies of the two maxima in the gyro-interaction curve and pointed out that the measurements of the geomagnetic field would be very accurate. Prof. Cutolo also spoke on "The Effects of Demodulation in the Ionosphere"; this method also provides an alternative method of measuring the geomagnetic field in the *E*-layer.

"Micropulsation in the Geomagnetic Horizontal Force and in Telluric Currents" was the subject of a paper by Dr. K. Burkhat (Munich). Dr. Burkhat pointed out that although the close connexion between geomagnetic variations and telluric currents has been known for more than a century, it has only recently been possible to decide which of the two phenomena is the cause and which the effect. At large distances from the electrodes, and in the case of small periods, the respective phases are in good accord. But for small periods (diurnal variation) and close to the electrodes, one finds a definite difference in the phase of the currents with respect to the geomagnetic variations. The difference in phase can be explained as due to the effect of resistance and reactance, since we now know that every telluric current connected with geomagnetic variation is due to induced currents. Dr. Burkhat then considered the statistics of pulsations and noted that the frequency curve for pulsations with periods of about 30 sec. coincides very nearly with the variation of maximum electron density in the *E*- and F_1-layers.

Prof. M. Matschinski (Paris) next spoke on "Problems of Geochemistry". He confined himself to what he described as the geographical aspects of geochemistry—which problem he formulated as that of finding the relationship between the chemical and geographical traits of given regions. As an example, he considered volcanic regions in the form of arcs; he recalled that he has already found a relationship between the density and the radius of curvature of the arcs. Prof. Matschinski showed several graphs with the view of demonstrating a statistical interdependence between geographical traits and certain chemical characteristics of rocks of the regions considered; for example, the mean percentages of the oxides of silicon, aluminium, calcium, magnesium, sodium, potassium and iron. These results were obtained from more than two thousand analyses.

The prize for meteorology offered by the Society was awarded to Prof. A. Giao and M. Ferreira for their paper "Introduzione alla climatologia dinamica dell'America Settendrionale, del Nord-Atlantico e dell'Europa". The following officers were elected for the period 1956–59: *President*, Prof. M. Bossolasco, *Council*, Profs. Aliverti, Lovera and Ranzi; *Secretary*, Dr. I. Dagnino.

V. C. A. Ferraro

MEMBRANE PHENOMENA

FARADAY SOCIETY DISCUSSION

THE Faraday Society held a general discussion on "Membrane Phenomena" in the University of Nottingham during April 10–12. Nearly two hundred scientific workers attended the discussion, the first of its kind to be held in Nottingham. The president, Mr. R. P. Bell, took the chair for the whole of the meeting, and the proceedings were opened by the sending of a message of greeting to Prof. F. G. Donnan, a founder-member and past-president of the Society, who is well known for his work in the field of membrane equilibria.

The discussion proper was preceded by the Spiers Memorial Lecture, given on this occasion by Prof. T. Teorell (Upsala), whose subject was "Transport Phenomena in Membranes". Prof. Teorell indicated how his own interest sprang originally from biochemical studies on hydrochloric acid in the stomach. He outlined structural studies on cell membranes, showing slides of striking electron micrographs taken

by F. S. Sjöstrand. He stated that theories must explain the five phenomena of ionic transport, membrane potential, electrical conductivity, ionic distribution equilibria, and the potential gradient and spatial distribution of ions within the membrane. In this connexion he discussed the achievements of four theories: those of the porous membrane, the homogeneous membrane, the energy-barrier model, and the fixed-charged membrane model. He pointed out how concentration gradients within a membrane may be in the reverse direction to the overall gradient between the two bulk solutions on each side of the membrane, leading to anomalous transport. He surveyed most ably the whole range of phenomena from the collodion membranes of Michaelis to the recent results of the Cambridge physiology school, concluding with reference to his own recent model which shows rhythmic variations of potential.

The general introduction was given by Prof. G. Scatchard (Massachusetts), who briefly outlined the programme to be followed, emphasizing the key part to be played by the thermodynamics of irreversible processes. T. L. Hill's (Bethesda) paper showed how the McMillan–Mayer solution theory, applied to the membrane equilibrium problem, leads directly to a value for the osmotic pressure. A combination of this theory with the classical Donnan method in certain instances leads to the membrane potential. R. Schlögl (Göttingen) divided total particle fluxes into those relative to the local centre of gravity, and a convection common to all particles, and showed that the latter may play an important part in membranes with an appreciable water permeability.

M. Nagasawa and I. Kagawa (Nagoya) found that the slope of the straight line connecting membrane potential and the logarithm of the ion activity for an ion-exchange membrane is less than RT/F, which they explained by abnormal ion activities within the membrane. F. Bergsma and A. J. Staverman (Delft), discussing a similar discrepancy for bi-ionic potentials, have found it particularly marked for hydrophile membranes and suggested water transport as the cause. G. Scatchard and F. Helfferich (Massachusetts and Göttingen) have found the abnormally high potentials observed in various cells with cation exchange membranes to be most marked when ions of different valence are present and to be markedly reduced by suitable stirring. They attribute the observations to a preference of the membrane surface for divalent ions. F. Helfferich (Göttingen) discussed the effects of Nernst diffusion films adherent to the membrane on its permeability. R. Neihof and K. Sollner (Upsala and Bethesda) have calculated rates of exchange of ions from membrane potentials of bi-ionic systems, demonstrating ionic selectivities approaching those observed in biological systems.

G. Manecke and H. Heller (Berlin-Dahlem) discussed the separation of non-electrolytes from electrolytes using an ion-exchange membrane, a problem also of interest to T. S. Mackie and P. Meares (Aberdeen), who compared sorption isotherms and diffusion-rates of ethanol in 'Zeocarb 315'. The ethanol is salted-in to the membrane, and it appears that two-thirds is in solution in the water swelling the membrane and free to diffuse, the remainder being adsorbed on the polymer chains.

J. W. Lorimer, E. I. Boterenbrood and J. J. Hermans (Leyden) have investigated membranes of viscose and sodium carboxymethyl cellulose, carrying out six measurements—specific conductivity, two transport numbers, two diffusion coefficients, and permeability—in order to permit evaluation of the six phenomenological coefficients of the thermodynamic theory. A. Despic and G. J. Hills (London), using membranes of cross-linked polymethacrylic acid, have subtracted electrosmotic flow from total flow, thus obtaining the flow due to solvated counter-ions. The latter quantity leads to a value of 9 ± 1 for the solvation number of sodium ion within the membrane. H. P. Gregor and D. M. Wetstone (Brooklyn) dealt with selective transport across sulphonic and carboxylic cationic membranes.

K. S. Spiegler, R. L. Yoest and M. R. J. Wyllie (Pittsburgh) considered the electrical potentials arising across porous plugs of ion-exchange materials, separating two solutions of the same electrolyte. In dilute solutions such plugs give almost perfect membrane potentials; but in concentrated solutions, conductance occurs largely through liquid in the pores, and the potential difference approaches the liquid-junction potential. The results are shown to be relevant to the suspension effect observed in *p*H measurements on suspensions and gels using a combination of glass and calomel electrodes. T. R. E. Kressman and F. L. Tye (London) showed how the transport numbers of sodium and chlorine ions in certain ion-exchange membranes decrease with increase in current density, an effect attributable to concentration diffusion. D. Hutchings and R. J. P. Williams (Oxford) considered how far cation-exchange membranes are suitable for analytical use. They have found conditions on the whole to be unfavourable, equilibrium potentials being reached only slowly, and in any case being often lower than those expected on thermodynamic grounds.

The last session was devoted to the properties of biological membranes. D. D. Eley and D. G. Hedge (Nottingham) examined the interaction of protein solutions with lipoid monolayers by a development of the Schulman–Rideal technique. Increases in surface pressure were interpreted to show the formation of a first sublayer of fully uncoiled protein chains, and a secondary layer consisting possibly of native protein. A. Rothstein (Rochester, N.Y.) concluded from studies of yeast cells that the cell surface is a "multimembrane compartmentalized structure". There is an outer barrier impermeable to proteins and holding enzymes such as saccharase and phosphatase. Within this there is a second membrane impermeable to anions and bivalent cations but permeable to potassium and hydrogen ions. Finally, there is a barrier impermeable to potassium and hydrogen ions, and containing metabolic pumps for phosphate and potassium ions. Dr. Rothstein outlined the evidence supporting this model: exchange reactions with radioisotopes are playing a big part in this kind of work.

W. D. Stein and J. F. Danielli (London) defined 'facilitated diffusion' as involving a specific structural relationship between the membrane and the diffusing species. As a model for the permeability of red-blood cells to glycerol, they consider a pore, possibly of protein, containing hydrogen-bonding groups that complex with the glycerol and lead to the observed kinetics, which are of the saturation or Michaelis–Menten type. Various glycols and alcohols were shown to be competitive inhibitors for the diffusion, and copper a non-competitive inhibitor. Freda Bowyer and W. F. Widdas (London) discussed the same problem for glucose and red-blood cells, considering in particular the kinetics of inhibition by dinitrofluorobenzene, which appears to be a fourth-order reaction. P. Mitchell

and J. Moyle (Edinburgh) have found the specificity and kinetics of phosphate transport in *Staphylococcus aureus* to resemble those for enzyme-linked reactions, and suggested that the enzyme-substrate complex forms the carrier for the facilitated diffusion. In the closing paper, R. D. Keynes and R. H. Adrian (Cambridge) described how in resting nerve or muscle the membrane is 25–100 times more permeable to potassium ion than sodium ion, the inside of the fibre being negative to the outside. As the action potential arrives, the membrane changes so that sodium ion becomes the more permeable ion, the inside of the fibre now becoming positive. There is no model to date which will account for the observation that the ratio of the permeability of sodium ion to that of potassium ion is linked to the electrical polarization of the adjacent membrane.

There was a lively discussion on many of the papers, and a number of contributors sought to show how ion-exchange systems can lead to a selective action on different cations. On the whole, it seemed that there is still something of a gap between the achievements of the physical chemist and the needs of the biologist with his complex systems; but it seems clear that this general discussion, and the published account which will appear in due course, should do much towards the further closing of this gap in the future. It is clear that the Faraday Society continues to provide a unique forum for the development of the border-line sciences.

D. D. Eley

ROYAL COMMISSION ON AWARDS TO INVENTORS

FINAL REPORT

THE fourth and final report of the Royal Commission on Awards to Inventors* concludes the record of the Commission's work. Besides listing decisions of the Commission since November 9, 1952, it discusses certain aspects of the more important of the 115 claims considered since the issue of the previous report. Only nine claims were dealt with under Head 1 of the Warrant during the period, and the Commission from the outset indicated its reluctance to deal with patent claims where the validity of the patent was seriously challenged. Several claims have consequently been referred to the Courts and other claimants have elected to have their claims considered under Head 3, that is, under the exercise of the Crown's bounty in granting an *ex gratia* award. By far the majority of claims heard by the Commission have been brought by such claimants, who have waived, or have not possessed, legal rights to support their claims. This procedure cannot be applied to claimants possessing patent rights who, after the period to which their claim relates, have assigned their patents to a third party. Normally, at the request of the Crown, the Commission has taken into account, in estimating the utility of the invention, its possible future use by the Crown as well as the past use. In a claim by J. R. Geigy S.A. and the Geigy Co., Ltd., relating to dichlorodiphenyltrichloroethane, the patents covering the invention had, at the date of hearing, been transferred to a newly formed company which was not a party to the claim, and the claimants undertook either to amend the claim by joining the patentees or to obtain an undertaking safeguarding the Crown from any further claim.

From time to time it has been urged on the Commission that exceptionally large use of an invention should be taken not merely as an important factor but as the predominant factor in determining the quantum of an award. It was on this principle that, in view of evidence showing the highly effective use of rockets in the later stage of the War, both in regard to material and to morale, the Commission, notwithstanding the heavy discount which the status of the claimants involved, recommended an award of £5,000 for the invention of a loose-charge rocket motor. In regard to novelty and originality of invention, the material question which has weighed with the Commission has been whether it has been the earlier or later publication or communication which has in fact led to the practical use of the invention by the Crown; nor has the fact that the claimant has patented his invention abroad, and thereby knowledge of the invention has been made available to an enemy country, necessarily disqualified the claimant from receiving an *ex gratia* award. Accordingly, the Swiss firm of J. R. Geigy S.A. was not disqualified from receiving an award in respect of the exceptional usefulness of DDT as a means of safeguarding the health of British troops; in the same way, notwithstanding the fact that the information contained in the late Prof. N. A. V. Piercy's earlier papers dealing with the mathematical basis of the design of aerofoil sections had become common knowledge among aeroplane constructors, the Commission, in view of evidence that his subsequent confidential communications to the Air Ministry were of permanent value for the construction of aerofoils, recommended an award.

The Commission has occasionally, as in connexion with the Pritchard principle for constructing bomb-sights, recommended an award where the inventive merit of the contribution consisted mainly of mathematical or theoretical calculations. Claims by employees of Crown contractors have generally been treated on the principle that, if the invention was made in fulfilment of the employee's duty to his employers, he should look to the firm he serves for an *ex gratia* reward for such services. The Commission was, however, able to treat the status of the claimants in the project known as Pluto and the inventors of the cavity magnetron as substantially the same as that of research workers directly paid by the Crown, since at the time they were lent or seconded to a government department for carrying out the experimental work which led to the invention. An award could be recommended to the inventor of the winged target or pilotless aircraft for towing behind aircraft because the company employing the inventor had waived its claim as patentees against the Crown in favour of the inventor. An award of £2,500 was recommended in respect of the disk seal triode in spite of some dubiety as to the validity of the claim, in view of some ambiguity in the contract in force and of the merit and extensive usefulness of the technique, particularly in blind firing from ships.

The gratuitous offer to the Crown and its contractors of the free user of a patented invention does not necessarily disqualify the owner of the patent from afterwards qualifying for an *ex gratia* award; but the Commission has held that surgical or medical

* Royal Commission on Awards to Inventors—Fourth and Final Report. Pp. 20. (Cmd. 9744.) (London: H.M.S.O., 1956.) 9*d*. net.

discoveries, in accordance with the recognized practice of the medical profession, become available for use of the Crown in the same way as for any members of the public. The only award recommended under Head 4 of the Warrant was for a claim in respect of the Sommerfeld track.

THE CATTLE EGRET

AN Old World bird which is a constant companion of cows has become established in the United States in the past fifteen years. Unknown there before its first appearance in Florida in 1942, there are now approximately two thousand birds in that State, according to Alexander Sprunt, jun., of the National Audubon Society (Smithsonian Institution News Release, April 13).

The bird is *Bubulcus ibis*, the cattle egret, which has been well known for many years in southern Europe, Africa and the Middle East. It is a small white egret with dark-brown feet and yellow legs and bill and is most remarkable for its strange, constant association with cattle. The close proximity to cattle is little short of astonishing. It keeps pace with the animal continually, usually close by the head, but sometimes near the fore or hind feet and occasionally under the abdomen. When an insect is disturbed, the bird darts out, catches it and returns. Now and then it reaches up and takes something from the body of the cow, or its legs. At times, the cow may be seen to push the bird aside with its muzzle, but appears not to object otherwise to the immediate closeness of its satellite.

A peculiar and unexplained characteristic of the bird is its habit of weaving the head and neck from side to side. A bird will suddenly stop feeding, stand perfectly upright, and weave the upper part of the body.

It feeds chiefly on grasshoppers and crickets. This may explain its fondness for cattle, which disturb these insects in the grass while grazing.

How the cattle egret got to the New World, especially the United States, is difficult to explain. It was first observed in British Guiana in 1937, but did not appear in the United States until five years later.

The cattle egret population is concentrated in Florida; but stray specimens have been observed as far north as Maine, and even Newfoundland, and inland to Chicago. Sprunt believes that a few pairs may have been blown over the Atlantic by wind currents.

SEA-BIRDS IN SWEDEN

IN 1950, regulations came into force in Sweden prohibiting the shooting of sea-birds during the early months of the year. The Swedish Institute of Forest Zoology has now completed investigations to show the effects of these regulations (Bull. Roy. Sch. Forestry, Stockholm, Sweden, No. 22; 1956). These show that everywhere the eider has increased substantially in numbers, while stocks of the velvet scoter were generally unchanged. This species usually arrives at the breeding places so late that it is scarcely affected by the legal spring shooting. There is, accordingly, a substantial difference between the eider and the velvet scoter in this respect, which supports the assumption that the prohibition of spring shooting—which applied only to the eider—had a salutary effect on the stock of that species.

The general trend regarding the stocks of Swedish sea birds since the new regulations were introduced has led to the following conclusions.

There is little possibility of distinguishing between male and female birds. Even if differentiation were possible, the male bird in the spring would still be essential for breeding. The risks of wounding birds in the large spring flocks are greater than those in the autumn shooting of migratory birds.

Birds are being shot which have been produced at other places and, at this time of the year, are returning to their production areas. This shooting cannot be motivated by game protection.

Although the amended regulations of 1950 have been of some benefit—indeed, of very appreciable benefit in the case of the eider—further review of the problems of spring shooting is now required.

The question of restricting spring shooting rights to the coastal population should be carefully considered, regardless of whether the shooting is done in public or private waters.

Should this prove impracticable, it is recommended that a general ban on spring shooting be introduced and that the coastal population be compensated by granting them prolonged autumn and winter shooting rights.

Permission might also be given for the limited shooting of male birds in production zones having well-ordered sea-bird protection. A certain amount of spring shooting along the migratory routes beyond the skerries but outside the production zones proper might be permitted as a transitional measure.

EVENING INSTITUTES IN BRITAIN

THE most popular studies pursued at evening institutes are those offering instruction in household handicrafts. More than a quarter of the student body registered, totalling nearly one and three-quarter million, are women taking classes in cooking, catering, home-furnishings, needlework and similar subjects for the improvement and decoration of the home.

This significant change in the character of evening classes is revealed by a Ministry of Education survey designed to help local education authorities, principals of institutes and teachers to meet the changing needs of young people and adults for purposeful leisure-time study and occupation*.

The change in public taste, and also in social conditions over a period of twenty years or so, is reflected in subject and attendance figures given. Between 1930 and 1952, the numbers of students studying vocational subjects in evening institutes declined considerably, while the numbers taking non-vocational subjects, such as art, music, handicrafts, dancing, and so on, increased. During this period vocational studies have to a great extent been transferred from evening to day work, largely as a consequence of the increasing readiness of employers to give young people time off during the day for study. The full-time work in technical colleges also increased greatly over the period.

* Evening Institutes. Ministry of Education Pamphlet No. 29. (London: H.M.S.O.) 3s. net.

The new emphasis on 'do-it-yourself' subjects has been accompanied by a change of character in the student body as a whole. Formerly, there were more men and women between the ages of eighteen and twenty-one attending senior vocational courses than any others. Now, the preponderant group is composed of students attending leisure-time classes, the majority of them women over the age of twenty-one.

Besides purely domestic subjects, older housewives and recently married couples take leatherwork, weaving, lace-making and basketry. So popular is the demand that the scope of subjects is steadily being extended to cover health, household management, parentcraft, and those aspects of sociology and psychology which affect the well-being of the family.

The number of young people between fifteen and eighteen attending evening classes is higher than it has ever been, though fewer now enrol in 'grouped' vocational courses. This feature is more noticeable in the south than in the industrial midlands and the north-west, where family tradition and pressure by employers still encourage attendance. Over the country as a whole the predominant type of class is the recreational one in which young people and grown men and women are to be found working together. Most of the work consists of making furniture for the home.

Full-time teachers are rare. Of 41,834 teachers engaged in 1952, only 67 were full-time assistants, and only about a third of them were professional teachers by day. The bulk of staff engaged were non-professional people with special knowledge or skill who became teachers in the evenings. The number of such instructors is increasing.

In addition to the expected kinds of instruction, classes dealing with local industries are not uncommon. There is a class on boat-building in a Thames-side town, for example; navigation is studied in a Devonshire fishing town; and welding courses are provided in a small midland town remote from a technical college. In urban evening institutes a common class is the owner-driver and car maintenance class. The instructor is often the proprietor of a local garage. A similar type of specialized class is radio and wireless, generally taken by a local radio trader.

The provision of classes in prisons and Borstal institutions is a development which has taken place since the Second World War. There are now classes in sixty-four establishments in England and Wales. In large establishments a separate institute can be formed; for smaller places the classes are usually attached to the nearest evening institute. Subjects of instruction are much the same as in the normal evening institute.

The survey examines in detail current practice in the organization and teaching of the arts, vocational courses, physical activities and subjects in the more formal curriculum provided by every evening institute. A suggestion is offered that courses and groups might with advantage be started in 'popular' science. Though it is not certain that teachers could be found for such an innovation, or that the public response would make it worth while, it is thought to be an experiment well worth trying.

HIGH-VOLTAGE PAPER ELECTROPHORESIS OF NON-VOLATILE ORGANIC ACIDS AND THEIR MIXTURES WITH AMINO-ACIDS

By Dr. D. GROSS

Research Laboratory, Tate and Lyle, Ltd., Keston, Kent

SURPRISINGLY few results of successful separations of organic acids (excluding fatty acids) by electrophoresis have been published, although on theoretical grounds the utilization of the variation of mobilities with dissociation constants would appear to be promising.

Earlier attempts[1] were limited in scope and success, and the separations of only a few free acids or derivatives of acids have been described so far. Recently, Berbalk and Schier[2] reported on a more elaborate investigation of the mobilities of a series of acids under the conditions of paper electrophoresis. In a study in this laboratory of the electrophoretic behaviour of organic acids at high potential gradients, we have found that, under the conditions chosen, even small existing differences in mobilities could be exploited for clean, rapid and reproducible separations, which, as the positions taken up by the various acids are mostly different from those on chromatograms, affords a useful complementary method for the detection and identification of many acids. In general agreement with Berbalk and Schier, we found a fairly good correlation between dissociation constants and migration rates, that is, mobility being directly proportional to K, and electrolyte solutions of about pH 2 to be most suitable for separations. Raising the pH of the solution increased the mobilities of some acids but also led to multiple spots. To effect a separation between two acids, their dissociation constants must vary by a factor of, at least, 2, although several exceptions have been found.

In further development of the technique[3], the cooling system has been improved by the introduction of aluminium alloy cooling plates of 1 in. thickness, with water flowing through grooves in the precision-ground, closely fitting plates, thus ensuring a better contact and heat transfer. With cooling water (tap water) of 9° C., energy of up to 3 W./cm.^{2} has been satisfactorily dissipated. The construction of a bigger power unit capable of delivering up to 150 m.amp. at up to 12,000 V. has made the application of potential gradients of up to 240 V./cm. to a strip of an effective length of 50 cm. possible. The dielectric strength of insulating films of polythene ('Telcothene') of a thickness of 0·015 in. has been found sufficient under these conditions. The exact measurement of voltages greater than 8,000 V. proved difficult, and certain corrections for lack of precision had to be made. A pneumatic uniform pressure device added since has greatly improved the evenness of migration.

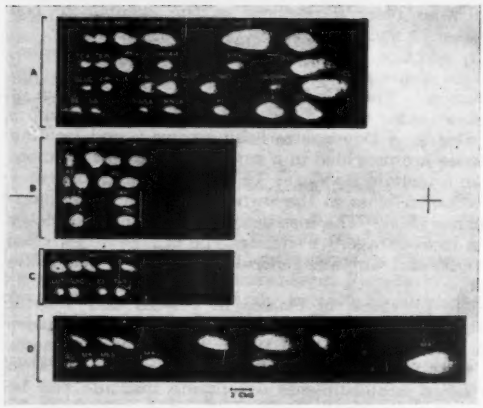

Fig. 1. Electrophoresis of non-volatile organic acids

Organic acids: *AD*, adipic acid; *BE*, benzoic acid; *C-AC*, *cis*-aconitic acid anhydride; *CI*, citric acid; *CIO*, citraconic acid; *D-CL*, dichloracetic acid; *D-HTAR*, dihydroxytartaric acid; *FR-DIPHO*, fructose-1-6-diphosphate (barium salt); *FU*, fumaric acid; *GL-PHO*, D-glucose-1-phosphate (potassium salt); *GLUC*, gluconic acid; *GLUT*, glutaric acid; *GLYC*, glycollic acid; *I-CL*, *iso*citric acid lactone; *IT*, itaconic acid; *α-K-BU*, α-keto-butyric acid; *2-K-GLUC*, 2-keto-gluconic acid; *α-K-GLUT*, α-keto-glutaric acid; *LA*, lactic acid; *LAE*, lævulinic acid; *MA*, malic acid; *MAE*, maleic acid; *MAO*, malonic acid; *M-CL*, monochloracetic acid; *MEC*, meconic acid; *MES*, mesaconic acid; 3-*NSA*, 3-nitro-salicylic acid (2-hydroxy-3-nitro-benzoic; 5-*NSA*, 5-nitro-salicylic acid (2-hydroxy-5-nitro-benzoic); *OX*, oxalic acid; *OXA*, oxalacetic acid; *OXU*, oxalsuccinic acid; 3-*PHOG*, 3-phosphoglyceric acid (barium salt); *PI*, picric acid; *PLC*, pyrrolidone-carboxylic acid; *PY*, pyruvic acid; *SA*, salicylic acid; *SSA*, sulphosalicylic acid; *SU*, succinic acid; *T-AC*, trans-aconitic acid; *TAR*, tartaric acid; *TARO*, tartronic acid; *TCA*, tricarballylic acid; *T-CL*, trichloracetic acid

Conditions: (*A*) 120 V./cm., 7·4 m.amp./cm., Whatman No. 3 *MM*. 4 × 22½ in. strip, 0·75 *M* formic acid, *p*H 2·0, mean temperature of cooling water 10° C., 20–50 μgm. of each compound (according to strength of acid) applied 3 in. from cathode end, ½ hr. (*B*) 100 V./cm., 5·2 m.amp./cm., 0·75 *M* formic acid + 1 *M* acetic acid (1 : 1) mixture, *p*H 2·25, 1½ hr. (*C*) 180 V./cm., 7·2 m.amp./cm., *p*H 2·25, ½ hr. (*D*) 200 V./cm., 13 m.amp./cm., *p*H 2·0, ½ hr.

The results obtained are illustrated by Fig. 1, which shows the position of forty-two organic acids after electrophoresis at various potential gradients for varying periods of time. Both solutions of formic acid and of mixtures of formic acid and acetic acid were used. To remove the volatile acids, the strips were dried at about 90° C. for 5 min. and then exposed to a stream of cold air for 1–3 hr., depending on the grade of paper used. The thicker Whatman No. 3 *MM* paper usually required 2½–3 hr. for removal of residual acid, whereas for Whatman No. 1 1 hr. was sufficient. Removal is essential when a *p*H indicator is used to reveal the separated non-volatile acids. A 0·1 per cent solution of bromo-phenol blue in 96 per cent ethanol saturated with sodium carbonate proved to be satisfactory, showing the acids as yellow spots or bands on a blue background. In general, there are four main groups of acids: (1) those with high dissociation constants (values at 25° C.) and thus moving fastest in the electrical field, typically represented by oxalic acid ($6{\cdot}5 \times 10^{-2}$); (2) those moving at a slightly slower rate, represented by maleic acid ($1{\cdot}5 \times 10^{-2}$); (3) those moving at somewhat less than half the speed of oxalic acid, represented by pyruvic acid (3×10^{-3}); and (4) the slow-moving acids, of which the fastest is represented by fumaric acid ($1{\cdot}0 \times 10^{-3}$) and the slowest by succinic acid ($6{\cdot}6 \times 10^{-5}$). In the latter group, glyoxylic acid ($4{\cdot}6 \times 10^{-4}$) can be cleanly separated from glycollic acid ($1{\cdot}49 \times 10^{-4}$). The alkaline hydrolysate of *iso*citric acid lactone yielded one major constituent, possibly *iso*citric acid, separable from citric acid. The time required for separations was ½–1½ hr., depending on voltage applied and types of acids present.

It was noticed that at *p*H 2 all amino-acids examined, being below their iso-electric point and thus positively charged, moved well away to the cathode, whereas the organic acids, being still negatively charged, moved to the anode. This offered a possibility of dealing with both groups of compounds, which very often occur together, on a single electrogram. The procedure adopted was to spray one half of the strip with ninhydrin, heat it and reveal the amino-acids present, and then spray the other half with bromo-phenol blue to reveal the non-volatile organic acids. Only taurine moved too short a distance away from the starting line and had, in case of doubt, to be checked by another run. The displacement of the weaker organic acids towards the cathode is, of course, due to electro-endosmotic and electrolyte flow effects and is mainly a function of voltage applied, time of run and original position of sample. Various mixtures of twenty different organic acids and twenty-one amino-acids were distinctly separated into their individual components at potential gradients of 160–240 V./cm. and within short periods of time, ranging from 13 to 30 min. per run. Some of the results are shown in Fig. 2.

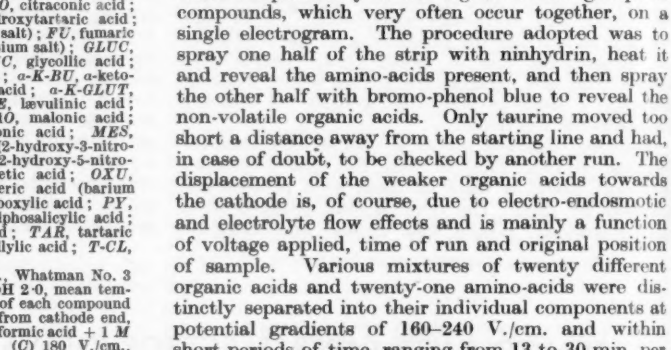

Fig. 2. Electrophoresis of mixtures of non-volatile organic acids and amino-acids Organic acids as in Fig. 1. Amino-acids: *α-AB*, α-amino-butyric acid; *β-AB*, β-amino-butyric acid; *α-AL*, α-alanine; *β-AL*, β-alanine; *AS*, aspartic acid; *ASE*, asparagine; *D-BRO-TY*, di-bromo-tyrosine; *D-IO-TY*, di-iodo-tyrosine; *GL*, glutamic acid; *GLE*, glutamine; *GLY*, glycine; *HP*, hydroxyproline; *I-LE*, *iso*leucine; *LE*, leucine; *ME*, methionine; *PH*, phenylalanine; *SE*, serine; *TH*, threonine; *TRY*, tryptophan; *TY*, tyrosine; *VA*, valine

Conditions: (*A*) 160 V./cm., 10·5 m.amp./cm., Whatman No. 3 *MM*. 2½ × 22½ in. strip, 0·75 *M* formic acid, *p*H 2·0, 20 μgm. of amino-acids and 50 μgm. of organic acids applied 8–10 in. from anode end, mean temperature of cooling water 12° C., ½ hr. (*B*) 160 V./cm., 10·2 m.amp./cm., *p*H 2·0, 27 min. (*C*) 200 V./cm., 13·8 m.amp./cm., *p*H 2·0, 13 min. (*D*) about 240 V./cm., 13·7 m.amp./cm., *p*H 2·0, water temperature 9° C., 24 min.

The range of acids applied is limited only by the length of the paper strip. The full range of acids requires a strip of a length of 80–100 cm. *Iso*leucine contained a well-separated contaminant of slightly lower mobility, and *iso*citric acid lactone had a contaminant of higher mobility. Tentative experiments have been started in connexion with an investigation into the possibilities of two-dimensional electrophoresis by extraction of the bands after the first run, concentration and re-application as spots for the second run. In this conjunction it was found that the position of glutamine in borate buffer of *p*H 9·2 is not as shown before[2], presumably due to decomposition of sample, but between starting line and asparagine. The separation of aspartic acid, glutamic acid, asparagine and glutamine is thus made possible.

Thanks are due to Mr. H. C. S. de Whalley, director of research, for encouragement, Dr. F. A. Isherwood for the gift of a sample of *iso*citric acid lactone, Mr. R. W. Butters for technical assistance, Mr. S. D. Gardiner for help in the design of the electrical power unit, and to the directors of Tate and Lyle, Ltd., for permission to publish this communication. [Feb. 2

[1] Wieland, T., and Feld, U., *Angew. Chem.*, **63**, 258 (1951). Michl, H., *Monatsh. Chem.*, **82**, 489 (1951). Neish, W. J. P., *Rec. Trav. Chim.*, **72**, 105, 1098 (1953). Smolarek, W., and Dlugosch, G., *Naturwiss.*, **41**, 18 (1954). Wieland, T., and Pfleiderer, G., *Angew. Chem.*, **67**, 257 (1955).

[2] Berbalk, H., and Schier, O., *Monatsh. Chem.*, **86**, 146 (1955).

[3] Gross, D., *Nature*, **176**, 72 (1955).

NATURE OF "CHALK HEATH" SOILS

By R. M. S. PERRIN

School of Agriculture, University of Cambridge

In certain areas on the Chalk of Great Britain, particularly on the South Downs, there are found shallow, strongly acid soils with *Erica cinerea* or *Calluna vulgaris* as invading or locally dominant species. Co-existing with these typical calcifuges are calcicoles, such as *Poterium sanguisorba*, which are mainly rooted in the underlying chalk. These unusual associations have been described by Tansley[1], who refers to them as "Chalk Heaths".

In a study of weathering and soil-formation on the English Chalk, briefly reported elsewhere[2], it was found important to decide whether these "Chalk Heath" soils consisted of decalcified and highly leached residues from chalk or whether they represented thin drift deposits. This question cannot be answered by field-examination alone. The soils are usually full of angular and nodular flints, as would be expected in a true chalk soil, and pass sharply into the underlying chalk. Further, their depth is generally consistent with the probable rate of accumulation of chalk insoluble residues since the cessation of solifluxion at the end of the Pleistocene. On the other hand, in some cases the soils appear to be too deep and too deficient in flints to be truly residual from chalk.

The mechanical and mineralogical compositions of several representative "Chalk Heath" soils were therefore compared with those of the acetic acid–insoluble residues from a number of chalks. Special attention was paid to soils from Manor Farm Down, Cocking, West Sussex, and Lullington Heath, East Sussex, where particularly good examples of "Chalk Heath" vegetation occur.

The mechanical composition of the small amount of insoluble residue from Upper and Middle Chalks varies little from place to place and is typified by the summation curve in Fig. 1 (I). Clay is invariably the dominant component, and there is no evidence of sorting in the sand grades. A soil truly derived from the residue of such chalk is typically found to give a mechanical composition curve as shown in Fig. 1 (II), the shape of this curve being mainly determined by the mechanical weathering of flint in the sand fractions. If, however, the amount of flint in each grade is estimated by microscopic examination, the curve can be re-drawn on a flint-free basis and is then of the form shown in Fig. 1 (III). These curves illustrate the fact that in soils truly derived from chalk some destruction of clay takes place as well as comminution of flint. As would be expected, there is no evidence of any sorting in the sand grades.

The "Chalk Heath" soils, on the other hand, give summation curves, typified by Fig. 2 (I), which indicate a high degree of sorting with a predominance of particles with diameters in the region of 0·03–0·04 mm. Comparison of these curves with those of loesses and 'brickearths' of recognized aeolian origin (for example, Fig. 2 (II) and (III)) strongly suggests that these soils are mainly derived from wind-blown material. Sorting and deposition by water would appear to be ruled out by the topographical situations of the heaths on the crests or slopes of escarpments.

On the other hand, while the soils correspond closely to some British brickearths, they differ from typical North American or European loesses in carrying higher proportions of clay and sometimes,

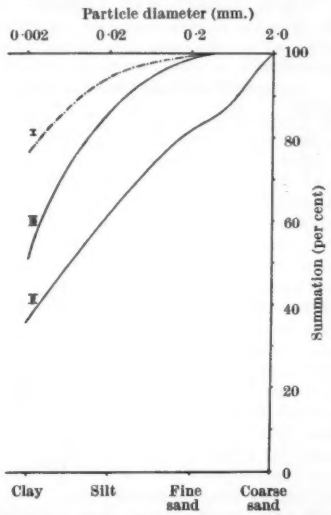

Fig. 1. Insoluble residues from a chalk and from its derived soil. (I), Upper Chalk, Hambledon Hill, Dorset; (II), Upper Chalk soil, Hambledon Hill, Dorset; (III), Upper Chalk soil, Hambledon Hill, Dorset, curve redrawn on flint-free basis
In accordance with common usage in pedology, the summation curves only show the composition of material less than 2 mm. in diameter. Larger particles are collectively referred to as 'stones'

but not invariably, of sand grains greater than 0·066 mm. in diameter. This extra sand, however, always consists of flint, which is apparently weathering *in situ*, since it occurs only in the coarser sand grades and as stones. In soils where the flint content is appreciable, a composition curve is obtained as in Fig. 3 (I); but if this is replotted on a flint-free basis, it assumes the form of (II), the upper part of which corresponds closely to that for a loess. The high clay contents of the soils can be explained in various ways. The most likely explanation is that the local wind-blown dusts carried appreciable amounts of clay in the form of soil aggregates of fine-sand dimensions and that this clay has been re-dispersed during the process of mechanical analysis.

The sand fractions contain very rich assemblages of heavy minerals, including green and blue amphiboles, zircon, rutile, anatase, ilmenite, tourmaline, garnet, apatite, kyanite, epidote, sillimanite and zoisite, together with a few grains of a variety of other minerals. Such assemblages are far too rich to have been derived from the insoluble residue of chalk, and the presence of blue amphibole strongly suggests that the material is derived from Pleistocene deposits. It must therefore be considered to be of Pleistocene or Post-Pleistocene age.

The clay fraction of a "Chalk Heath" soil is made up of kaolinite and dioctahedral vermiculite. This differs markedly from the clay in the insoluble residue of chalk, which consists of illite and dioctahedral montmorillonoid. However, experience with soils truly derived from chalk and from various tills in East Anglia has shown that it is usual for montmorillonoid to weather to kaolinite and for illite to alter to dioctahedral vermiculite. The kaolinite–vermiculite assemblage appears, in fact, to be a typical weathering product in free-draining soils in Britain. The mineralogy of the clay fraction thus unfortunately provides no evidence as to the origin of the soil.

From the available evidence it thus seems likely that the "Chalk Heath" soils originate from the deposition of wind-blown material on flinty pavements, produced by the local weathering of chalk, on

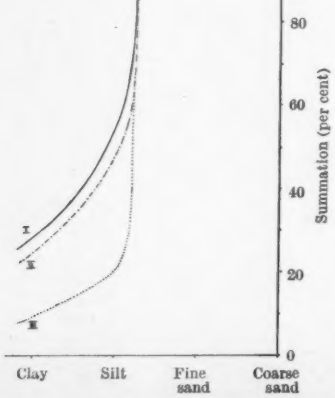

Fig. 2. (I), "Chalk Heath" soil, Lullington Heath, East Sussex; (II), Brickearth, Wye, Kent; (III), Loess, Herford, Germany

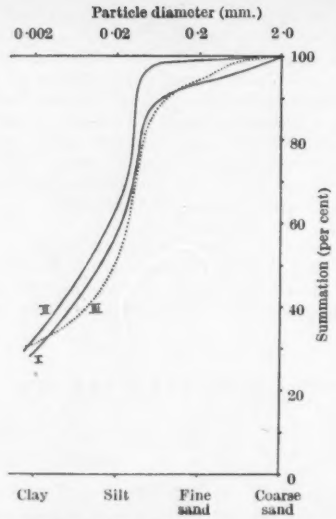

Fig. 3. (I), "Chalk Heath" soil, Manor Farm Down, West Sussex; (II), "Chalk Heath" soil, Manor Farm Down, West Sussex, curve redrawn on flint-free basis; (III), Topsoil overlying Clay-with-flints, Combe Hill, south-west of Wendover, Bucks

sites from which Clay-with-flints and other Tertiary deposits had previously been stripped by peri-glacial or normal erosion. This hypothesis is supported by the practically identical shapes of summation curves (on a flint-free basis) for soils from widely separated localities and by the occasional presence adjacent to "Chalk Heaths" of deeper deposits, again with the same mechanical composition but with a lower proportion of flint stones.

If this suggested origin be correct, it would be expected that topsoils giving composition curves of the same type would be widespread and would occur on various geological formations. Such soils have now, in fact, been located on the Chalk in the Yorkshire Wolds and on Clay-with-flints in Savernake Forest, Berkshire. Deposits of a slightly different type but also with a marked concentration of particle diameters in the region 0·03–0·04 mm. have been found overlying the Chalk on the Berkshire Downs, red Clay-with-flints on the Chilterns (see Fig. 3 (III)) and Carboniferous Limestone in Derbyshire. It therefore seems likely that careful mechanical analysis might reveal thin deposits of similar loess-like material in many soils in Britain which have not been too greatly disturbed by long-continued agriculture.

It would clearly be of great interest to know when the material was laid down. Cornwall[3] has recently shown from archæological evidence that loess was probably deposited in England as late as the Bronze Age. It is hoped that in due course it will be possible to date the deposits on the "Chalk Heaths" using similar methods.

The assistance of Dr. M. Black, of the Sedgwick Museum, Cambridge, in the execution and interpretation of heavy mineral analyses is gratefully acknowledged. Details of the complete investigation will be published elsewhere.

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[2] Perrin, R. M. S., "The Genesis of the Soils overlying the Chalk", Brit. Assoc., Bristol meeting, 1955.

[3] Cornwall, I. W., *Proc. Prehist. Soc.*, Part 2, 129 (1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Impulsive Radio Signals from the Planet Venus

RADIO signals of an impulsive or burst-like nature which appear to come from the planet Venus have been detected at the Ohio State University at a wave-length of 11 metres. The observations were made with an interferometer antenna consisting of two colinear arrays of six horizontal half-wave-length elements one-quarter wave-length above ground. Each array is backed up by a reflector element, which, with the ground, forms a corner reflector. The arrays are separated by 426 ft. along an east–west axis. The receiver operates a pen recorder with a time constant of about one-quarter second.

Twice on May 23 and once on May 30, 1956, intense signals were observed when Venus drifted through the main antenna beam. On each occasion the signals were recorded for a period of two to three hours. They appear on the recorder tape as a succession of randomly spaced sharp spikes each representing a burst of short duration (1 sec. or less). The appearance somewhat resembles records of signals received from Jupiter[1]. On each of the three records the envelope of the spikes shows an interferometer lobe pattern in close agreement with one to be expected for a radio source at the position of Venus. The likelihood of confusion with the Sun or other planets is remote, since these were well separated in angle from Venus. Radio sources such as Cygnus *A*, Cassiopeia *A* and Taurus *A* were also well removed. Furthermore, they exhibit a different appearance on the tape and have fixed, instead of changing, celestial co-ordinates.

On all the three records the bursts are observed to pass through peaks spaced about 90 min. apart, at which times they are most frequent and intense. The record of May 23 is of particular interest in this respect since a period of activity was observed between 1300 and 1500 E.S.T. and again between 1900 and 2100, both periods showing similar peaks of activity 90 min. apart. The Sun set at 1947 E.S.T. There is some indication of activity between 1500 and 1900, but Venus was near the edge of the main beam during this period.

In about three months of searching for signals from Venus since February 1, 1956 (no observations were made during April), the only periods of intense activity observed were on May 23 and 30. Possible indications of activity from Venus were noted on February 15 and March 6 but with less certainty. It may or may not be significant, but on May 17 and 26 there were large solar flares. These dates are six and four days, respectively, in advance of May 23 and 30, on which days signals from Venus were observed.

The peak power flux-density of the bursts of signals from Venus have often been recorded at several times the value of the Cygnus *A* radio source at the same frequency (26·7 Mc./sec.). Assuming that Cygnus *A* has a power spectrum proportional to the wave-length, the peak radiated radio-power flux-density of a burst from Venus is:

$$38\times10^{-24}\times9\cdot4\times2\cdot5 = 8\cdot9\times10^{-22}\ \text{W. m.}^{-2}\ \text{(c./s.)}^{-1}$$

where 38×10^{-24} W. m.$^{-2}$(c./s.)$^{-1}$ is the value for Cygnus *A* observed[2] at 250 Mc./sec., 9·4 is the spectrum ratio, and 2·5 is taken as the Venus to Cygnus *A* ratio at 26·7 Mc./sec. on May 23. Actually, the Cygnus *A* spectrum may be flatter than assumed, but compensating this effect the peak burst of power may be higher than recorded since the receiver time constant is one-quarter second and the burst may be of considerably shorter duration. The distance of Venus on May 23 was 0·4 astronomical unit. Assuming that the Venus source radiates isotropically and neglecting the loss through any ionosphere which the planet may have, the peak power in a burst from Venus is about 40 watts per cycle per second of band-width. This is about 0·003 of the value observed for a burst from Jupiter.

If one assumes, in the absence of information about the spectrum of the signal, that the power is constant over a 10-Mc./sec. band-width, the integrated peak radiated radio power of a burst from Venus is 4×10^8 watts (or 400 megawatts). However, if the spectrum is more like that for terrestrial lightning, this may be too low by a factor of about 10, making the value 4×10^9 watts. The total peak power in a terrestrial lightning stroke has been estimated at 10^{13} watts or more[3]. Assuming a conversion efficiency to radiated radio power of 0·001 yields 10^{10} watts of radiated radio power for a terrestrial lightning stroke. This is somewhat larger than the probable value for Venus. Thus, it would appear that a lightning discharge phenomenon on Venus of the intensity of the terrestrial variety (or weaker) would have sufficient power to be the mechanism involved.

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Interpretation of Ionospheric Measurements made during Solar Eclipses

Hunaerts and Nicolet[1] have pointed out that the interpretation of *E*-layer measurements made during solar eclipses is very sensitive to the value of the effective recombination coefficient ($\alpha \times 10^{-8}$ cm.^{3} s.$^{-1}$) in the range $\alpha = 1$–3. For the eclipse of February 25, 1952, at points in the belt of totality, a value of α near the lower end of this range implies, in general, that the west limb of the Sun must have been much brighter than the east limb, and also that there can have been no source of ionizing radiation outside the visible disk. Conversely, a higher value of α requires the existence, in the corona, of sources which remained unobscured during totality, and only a small difference between the brightness of the west and east limbs. At Khartoum, for example, the intensity of the coronal component (I_c) and the difference between the intensities of the sources near the west and east limbs ($I_w - I_e$), both expressed as a percentage of the total radiation, are given by $I_c = 12 - 18/\alpha$ and $I_w - I_e = 2 + 39/\alpha$. The arbitrary assumption that there was no coronal radiation thus leads to the result: $\alpha = 1\cdot5$.

Fortunately the interdependence of I and α suggests the possibility of using a method of finding α which makes no arbitrary assumptions about I. If

ionospheric measurements are made during the same eclipse at two stations, it ought to be possible, in principle, to express the intensity of a given source in terms of two different functions of α; equating these functions would then allow α to be determined. This technique has proved to be practicable using data obtained at Khartoum and Ibadan in 1952; the resulting expressions for the intensity (per cent) of the west limb source are $I_k = 15 + 18/\alpha$ and $I_i = 29 + 2/\alpha$, and similar expressions have been derived for the uniform disk and east limb components. The solution of the equations for the three sources allows the values of α at the two stations to be determined simultaneously; it is found that the difference between them is not significant and that the most probable value is $\alpha = 1{\cdot}2$.

This low value for α and the implied absence of any coronal radiation are at variance with the conclusions reached by Hunaerts and Nicolet, who find that $\alpha = 4$ and that 15 per cent of the total radiation originates in the corona. A valuable check would be provided if similar determinations of α could be carried out using the measurements made in other parts of Africa during the 1952 eclipse, and a fuller account of the method used, including numerical data for Khartoum and Ibadan, will appear elsewhere[3].

Hunaerts and Nicolet have also referred to the observation that ionospheric measurements made during the 1954 eclipse imply equatorial brightening and polar darkening of the Sun's disk[3]. This conclusion is independent of the assumed value of α, a change in which leads only to a change in the relative brightness of the west and east limbs; the amount of polar darkening and the magnitude of the uniform disk component are very insensitive to changes in α. As the 1954 measurements were not made in the belt of totality, no information on the possible existence of coronal radiation can be given.

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Atomic Time and the Definition of the Second

The experience gained[1] with the cæsium resonator has shown that it can be used for establishing a unit of time interval with great ease and accuracy, and it is now important to decide how this new facility can best be incorporated into the general framework of time measurements. It is necessary first to outline the present position with rather more practical detail than has been given in the recent correspondence in these columns[2,3].

The unit provided by the present time signals is based on the diurnal rotation of the Earth, the astronomical observations being corrected for known irregularities and also smoothed over long intervals by means of quartz clocks. It is known in Britain as the second of provisional uniform time and in America as that of U.T.2. Corrections to the signals are published by the observatories responsible for them after some delay, about six months in the case of the Royal Greenwich Observatory. These corrections are obtained from a statistical study of the observations and of clock performances and thus give the most probable value of the unit. It is important to realize that the corrected assessment of the unit involves certain assumptions being made about the behaviour of the clocks and of the Earth, but there is good evidence that it is in general uniform to ± 4 parts in 10^9 during a year.

It is internationally recommended[4] that, in view of the known variations, amounting to ± 4 parts in 10^8 during the last century, in the period of rotation of the Earth relative to other periodicities of the solar system, the second of ephemeris time should be used for precise work. This is based on the length of the tropical year[5], which is subject to a small secular change and is therefore referred to the particular epoch 1 900·0, the definition of the second being 1/31 556 925·975 of the tropical year for 1 900·0. The accuracy with which this new unit can be given is governed by the accuracy with which the current tropical year can be determined. This determination is made in practice from observations of the Moon, and W. Markowitz, using the dual-rate camera which he has recently developed[6], estimates the probable error to be ± 5 parts in 10^9 for measurements extending over one year[7]. To obtain the accuracy of ± 5 parts in 10^{10} (as an outside limit, not probable error), already being used in frequency measurements, the observations would thus have to be extended over more than ten years, and this long interval would have to be subdivided into equal seconds. It appears, therefore, that the second of ephemeris time can be made available with the required accuracy only by using an atomic standard for interpolation purposes.

The correlation of the two units is thus not easy and, moreover, there may be a gradual departure between the two as pointed out by Bullard[8]. There may be some point, therefore, in the suggestion made by Clemence[9] that they should be defined independently, and that a separate name should be given to the atomic unit; but it would almost certainly give rise to confusion, because the physicist who usually obtains his time from time signals would have to inquire into the precise nature of those signals. It is surely preferable for the responsible authorities to make available a single unit of time, as is strongly advocated by Pérard[3]. Pérard states that this unit should be defined in terms of the astronomical second, the frequency N of an atomic standard being given by the relationship:

$$Nt = \frac{\text{tropical year for 1 900·0}}{31\,556\,925{\cdot}974\,74}$$

The difficulty here is that, in spite of the number of figures with which the denominator apparently can be given, the tropical year is unlikely to be determined more closely than to ± 5 parts in 10^{10} in ten years, which means that the full accuracy of the atomic standard would remain latent for that time. Physicists and radio engineers would have no alternative but to adopt some value and use it as an independent atomic unit.

The following tentative proposals are put forward in an attempt to overcome this difficulty: to make the atomic standard immediately available but to preserve a single unit of time closely linked with, although not defined by, that given by astronomical observations.

(1) The provisional unit of time should be the time of 9 192 631 830 cycles of the cæsium $Fm,(4,0) \longleftrightarrow (3,0)$ resonance at zero field, and named 1 provisional second. This is the frequency obtained[9] in terms of the provisional uniform second in June 1955, but it turns out to be very near the value expressed in the average provisional uniform second for the period June 1955–June 1956, and no alteration is therefore recommended.

(2) The joint work of the National Physical Laboratory and the U.S. Naval Observatory at present in progress should be continued to obtain the value of the cæsium frequency in terms of the second of ephemeris time for a period of, say, five years, when the precision should approach 1 part in 10^9. As the length of the tropical year is varying by 2 parts in 10^{10} per year[10], there is little point in relating the two units more closely than this. Indeed, it may be sufficient to accept the relationship with a lower accuracy which will be available in a shorter time.

(3) This new frequency should ultimately be adopted for the definition of the second. It is expected that the value will not differ by an amount which is significant for most purposes from the provisional value, as the difference between the units of provisional uniform time and of ephemeris time is believed to be small during the present period. A step adjustment could also be made to bring actual time (epoch) to the ephemeris time-scale.

For the purpose of the definition the frequency will be given to 1 part in 10^{10}, as it will certainly be possible in the near future to calibrate the working standards in terms of the resonance with that precision.

(4) The closest relationship should be maintained by the appropriate authorities between atomic time and astronomical time in order to determine any departure between the two systems and also to preserve the continuity of time determinations over long periods. Quartz clocks and astronomical observations would be used for integrating atomic time just as quartz clocks are now used to subdivide astronomical time.

(5) As other atomic standards come into use, their frequencies should be expressed in terms of the provisional second defined in (1), and, later, in terms of the second as defined in (3). The provisional second is already available through the *MSF* standard-frequency transmissions[11,12].

In making these proposals, the understandable reluctance to break with a practice as old as civilization is fully appreciated; but a consideration of the precision of measurement alone shows that the astronomical unit of time is no longer sufficiently accurate for modern measurements of frequency and time interval.

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Terrestrial Heat-Flow in Hungary

Numerous borehole temperature measurements have been made in the Carpathian Basin during the past seven decades. It has been found that the value of the geothermal gradient lies between 40 and 70 deg. C./km. The causes of this high value have not yet been established, since the thermal conductivity of the rocks has not yet been measured.

In the Liassic coal basin of South Transdanubia at Zobák and Hosszuhetény, the sinking of four big shafts offered a favourable opportunity of determining terrestrial heat-flow. The shafts have at present reached depths of 550 and 600 metres respectively, and have been sunk throughout in the same Liassic calcareous shale. In order to determine heat-flow, several measurements of the virgin rock temperature were taken in the course of sinking the shafts. The thermal conductivity of rock samples was measured by a method very similar to that of Benfield[1] and Bullard[2].

The heat flow was computed according to the following formula:

$$q = \frac{T_2 - T_1}{\sum_{i=1}^{n} \frac{\Delta h_i}{\lambda_i}}$$

where Δh_i is the thickness of stratum with thermal conductivity of λ_i. According to measurements taken in shafts at a distance of 90 metres, the mean value and probable error of the terrestrial heat-flow is:

$$10^6 q = 3{\cdot}035 \pm 0{\cdot}010 \text{ cal./cm.}^2 \text{ sec.}$$

Our measurements taken in shafts are more direct and reliable than those performed in boreholes, as the virgin rock temperature at the bottom of the shaft is affected by not more than 0·02 deg. C. by ventilation. In boreholes it is the temperature of the drilling fluid that is measured, and this differs, often considerably, from the virgin rock temperature.

It is believed that the present measurements are the first ever attempted in continental Europe[3], and that the high value obtained may be of interest for the geophysicist and geologist. This high value affects mining operations rather unfavourably. Since at a depth of 570 metres the virgin rock temperature is 36° C., it may be assumed to rise to 60° C. at 1,000 metres to which it is planned to sink the shafts. Such high temperatures will present special problems in mine ventilation.

A detailed account of this work will soon be published elsewhere.

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Effect of Altitude on the Position of the Magnetic Pole

In the most recent analysis of the Earth's magnetic field (for the epoch 1942), Spencer Jones and Melotte[1] evaluated forty-eight coefficients in the spherical harmonic expansion of the magnetic potential. Using their values for a spheroidal Earth, the X (northerly)

and Y (easterly) components of the Earth's magnetic field were calculated at heights of 100 km. and 250 km. above the Earth's surface for $\theta = 5°$, 10°, 15°, 20° and 25° and for $\varphi = 240°$, 250° and 260° E., where θ and φ are the co-latitude and longitude respectively. The heights 100 and 250 km. were chosen to correspond to the E- and F-layers of the ionosphere. For the purpose of comparison, X and Y were also evaluated at the Earth's surface and in every case the value of $H = (X^2 + Y^2)^{1/2}$ was computed.

In order to trace any movement of the magnetic pole with increasing height, the above calculations were repeated on a much finer grid in the vicinity of the pole. Thus X, Y and H were computed for values of $\cos\theta = 0{\cdot}958$, $0{\cdot}962$, $0{\cdot}966$, $0{\cdot}970$, $0{\cdot}974$ and $0{\cdot}978$, and $\varphi = 256°$, 257°, 258°, 259° and 260° E. The results were plotted graphically, and the position of the pole at different altitudes is given in Table 1.

Table 1

Height	cos θ	φ
Ground-level	0·970	258° E.
100 km.	0·972	258°
250 km.	0·975	258(½)°

The position of the pole at ground-level is thus 76° N., 258° E., that is, 102° W., which agrees with the position given by Spencer Jones and Melotte[1]. It may be noted that for a spherical Earth, instead of a spheroidal Earth, they obtained the position as 77° N., 103½° W. It should be remembered that this is the position for the epoch 1942. For the year 1956, the latitude must be increased by approximately one degree with no appreciable change in longitude.

Table 1 shows that there is a gradual shift in the position of the pole with increasing altitude, the relation between cos θ and altitude being linear. At a height of 250 km. the pole has moved northwards one degree, there being no measurable change in longitude. This trend cannot continue far, since, with increasing altitude, the effects of the higher harmonics in the expansion of the magnetic potential become less and less important. If the trend did continue, the magnetic pole would be directly above the geographical pole at a height of 1,500 km. It has been shown, however, that for $\theta = 0°$ the horizontal field cannot vanish at any altitude.

An interesting feature of the calculations was that in certain cases the value of H increased with height, due mainly to an increase in the X-component. This is not likely to be significant, however, and most probably reflects small errors in the coefficients of the harmonic expansion. Although the increase could be accounted for by currents in the ionosphere, this explanation can scarcely be true, since it was assumed from the outset that there was no external component of the Earth's magnetic field.

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Harmonics in a Multi-Story Structure

The design of structures to withstand earthquakes is largely empirical. It is found, from experience, that, if the structure is designed to withstand a horizontal acceleration of one-tenth that of gravity, the building suffers no more than superficial damage even in a major earthquake. Spectra of earthquakes prepared by Housner[1] would appear to indicate that accelerations much greater than this design value are reached. If any tall building is postulated, the lack of a theoretical basis for the accepted design criterion causes considerable hesitation, particularly where one or more of the harmonic frequencies of the building may coincide with partial frequency components of the earthquake. This uncertainty is largely responsible for structure design in New Zealand, and in some American areas, being limited to a maximum height. (In New Zealand this maximum height is 100 ft.) Prof. L. Jacobsen and Robert S. Ayre[2] commented on a uniform building (mass and rigidity constant at each story): "Current design rules give reasonable results for the fundamental mode shears only and the higher mode shears require considerable increases in the proportionality or percentage factor, especially in the upper part of the building".

The possibility of excitation in the higher modes either being serious in itself or adding to the fundamental excitation in such a way that inter-story shear may become excessive has been one of the major uncertainties in the subject. Recent work at the Dominion Physical Laboratory, where an electrical analogue of a ten-storied building has been built and excited by earthquake accelograms, has shown that excitation of the harmonics for the case of a uniform building may be ignored. However, if the building is designed to the current design code (inter-story stiffness proportional to total mass above the inter-story section), then the harmonics do have a small effect on the upper two storys. The effect is shown in Figs. 1, 2 and 3 in the form of spectra of one particular earthquake.

These spectra are a plot of the fundamental period of a uniform ten-story building against the maximum equivalent static acceleration producing the same stress which occurs during the passage of the particular earthquake. The single-story spectrum shows the major peak at 0·4 sec. period. Fig. 2 and 3,

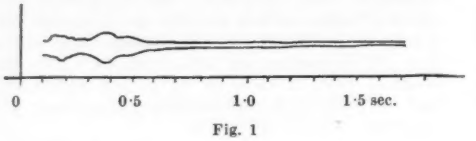

Fig. 1

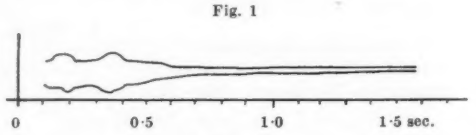

Fig. 2

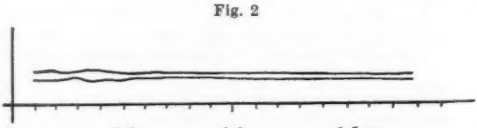

Fig. 3

Spectra for a uniform building: (1) single degree of freedom; (2) first story; (3) tenth story

Fig. 4. Resonant amplitudes of the first three modes of oscillation for a fixed exciting acceleration

taken at the ground floor and top floor of a ten-story structure, show no peak at 1·2 sec., although the second harmonic of a structure of 1·2 sec. fundamental is 0·4 sec.

Fig. 4 shows the amplitudes developed throughout a ten-story structure when the ground undergoes a sinusoidal displacement at a constant value of peak acceleration and the frequency is made that of the various harmonics. The percentage damping is arranged to be the same for each mode.

It is concluded that, in a tall building, modes of oscillation other than the fundamental have far less effect than previously supposed. It is hoped that further work on the analogue machine may provide a theoretical basis for a more exact building code.

The work is to be published in detail elsewhere.

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Mobility of π-Electrons in Heterogeneous Linear Molecules

The observation that the lowest energy singlet transition in the electronic absorption spectrum of *trans*-chalcone (compound 8 in Table 1) had the same oscillator strength as that for *trans*-stilbene[1] led us to investigate other compounds of the type Ph—*X* and Ph—*X*—Ph, where —*X*— stands for a conjugated chain containing hetero groups such as —CO—, —N=N— and —CH : N.N : CH—.

In the majority of these compounds, a considerable part of the total absorption intensity is found in the lowest energy $\pi \rightarrow \pi^*$ transition, the oscillator strength ($f = 4{\cdot}32 \times 10^{-9} / \varepsilon \, d\nu$) generally being measurable with accuracy, since the absorption band is well separated from the remainder of the spectrum[2].

Kuhn, in a semi-theoretical treatment of polyene chains as a system of coupled linear oscillators[3], concluded that the electrons were about 90 per cent mobile and that, among other things, the oscillator strength of the lowest singlet–singlet transition could be calculated from the equation

$$f = 0{\cdot}178n \qquad (1)$$

where n is the number of —CH : CH— groups in the chain. For the diphenyl-polyenes he calculated that a phenyl group was equivalent to 1·5 double bonds.

In particular, for *trans*-stilbene, our observed f-value for the $\pi \rightarrow \pi^*$ transition is 0·755 and $n = 4$, which leads to the empirical equation

$$f_{obs.} = 0{\cdot}189n \qquad (2)$$

If equation (2) is extended to include hetero compounds such as those in Table 1, it may be re-written more generally as

$$f_{obs.} = 0{\cdot}189(1{\cdot}5a + b + n_{het.}) \qquad (3)$$

where a is the number of phenyl and b the number of vinyl groups; in any molecule, n_{het}, the double-bond equivalent for each hetero group, may then readily be calculated.

The results are listed in Table 1. They show that the carbonyl group makes virtually no contribution to the $\pi \rightarrow \pi^*$ transition intensity; acetone itself exhibits very weak absorption in the near ultra-violet region of the spectrum (compound 2). The azo group also appears not to make an intensity contribution to the $\pi \rightarrow \pi^*$ transition in azobenzene, although it gives rise to a lower-energy weak $n \rightarrow \pi^*$ absorption. On the other hand, the alazine group (compounds 11 and 12) is equivalent to at least two double bonds, that is, to two conjugated vinyl groups.

The exception among the ketones is cinnamaldehyde, for the behaviour of which there is no obvious explanation on the basis of the present discussion, especially since benzaldehyde behaves in the same way as the remaining ketones. For di-cinnamalazine, and to a less extent for di-benzalazine,

Table 1

No.	Compound	Structural formula	$f_{obs.}$	Hetero group	$n_{het.}$	$\varepsilon_{max.}$	$\nu_{max.} \times 10^{-3}$ cm.$^{-1}$
1	Acetoneazine*	$Me_2C : N.N : CMe_2$	0·045	—	—	~3,000	~46·0
			—			8,000	50·0†
2	Acetone*	MeCOMe	$5{\cdot}0 \times 10^{-4}$	—CO—	0	17·4	37·8
3	Benzaldehyde	PhCHO	0·28	—CHO—	0	13,300	40·0
4	Cinnamaldehyde	PhCH : CH.CHO	0·615	—CHO	0·75	25,000	34·3
5	Stilbene	PhCH : CHPh	0·755	—	—	29,000	33·8
6	Benzil	PhCOCOPh	0·55	—CO.CO—	0	21,200	38·5
7	Azobenzene	PhN : NPh	0·56	—N : N—	0	20,800	31·4
8	Chalcone	PhCH : CHCOPh	1·755*			24,400*	32·2*
			0·750	—CO—	0	23,500	31·9
9	Benzalacetone	$(PhCH : CH.)_2CO$	0·930	—CO—	0	35,800	30·2
10	Cinnamalacetone	$(PhCH : CHCH : CH.)_2CO$	1·35	—CO—	0	54,900	26·6
11	Benzalazine	$(PhCH : N.)_2$	0·970	—CH:N.N:CH—	2·2	37,500	33·3
12	Cinnamalazine	$(PhCH : CHCH : N.)_2$	1·53	—CH:N.N:CH—	3·2	65,900	28·9

* In water; all other spectra measured in 95 per cent ethanol. † Absorption still rising.

the situation is complicated by the fact that a further transition moderately intense in acetone-azine and possibly $n \rightarrow \pi^*$ in character, appears to have been shifted and intensified so as to overlap the strong absorption at low frequencies, giving apparently high values to n_{het}.

The conclusion from this work is that conjugated hetero groups in the chain of elongated planar molecules cause no decrease in mobility of the carbon π-electrons, even though such groups possess different types of orbitals from those in homogeneous conjugated molecules. This appears to be true whether or not the hetero groups themselves make a contribution to the intensity of the transition under consideration. Any such decrease in mobility would result not only in a marked decrease in intensity of the absorption band, but also in changes in its shape and location, with a consequent tendency for the band to overlap the remaining absorption at higher frequencies. On the contrary, a separate intense low-energy band is observed for the compounds containing one or two phenyl groups. These compounds must be in their fully extended 'all-*trans*' form, since it is well known that the corresponding stereoisomers containing one or more *cis*-bonds give rise to less intense absorption at the low-frequency end of their spectra[1,4].

On the basis of the free-electron model, Bayliss has shown[5] that the intensity of the lowest-energy transition in a homogeneous conjugated polyene should be independent of its overall length and dependent only on the number of carbon π-orbitals. The present results indicate that this theory may be extended to include at least some types of conjugated heterogeneous molecules.

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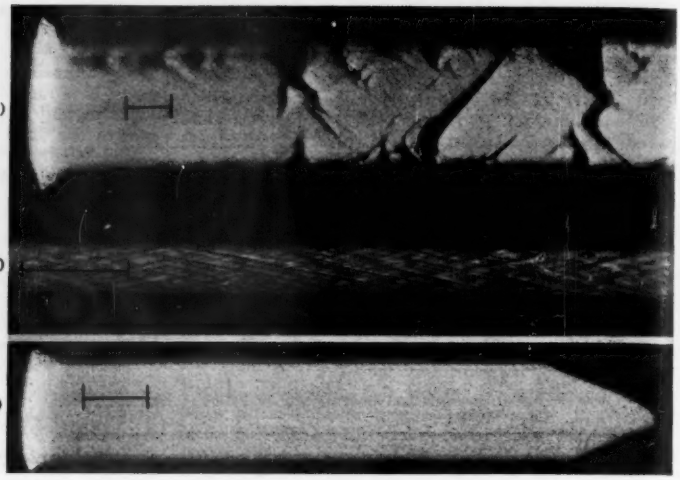

Fig. 1. End-on view. Dark-waves in nitromethane. Length of horizontal line corresponds to 1 microsecond

Fig. 2. End-on view. Dark-waves in nitromethane–acetone. Length of horizontal line corresponds to 1 microsecond

Fig. 3. End-on view. Nitromethane detonation running beyond foil lining and failing. Length of horizontal line corresponds to 1 microsecond

Detonation Phenomena in Homogeneous Explosives

We have observed in this laboratory that the manner in which a detonation proceeds in a homogeneous explosive is more complex than had previously been thought. Regions of relatively low luminosity have been observed in the detonation fronts of homogeneous solid and liquid explosives under certain conditions of diameter and confinement. Although these regions of low luminosity, which we call 'dark-waves', are larger and more numerous under conditions close to failure, they have also been observed under conditions in which the detonation is apparently proceeding at normal, constant velocity.

Fig. 1 shows the camera trace obtained with a rotating-mirror camera[1] looking end-on at a cylindrical tube of detonating nitromethane as the front advanced toward the camera. The nitromethane was confined in a glass tube, 0·642-in. internal diameter, and was at an initial temperature of 24° C. The rotating mirror was operating at 1,000 rev./sec., which corresponded to a writing speed of 1·8 mm./μsec. on the recording film. A 0·05-mm. slit was used in the camera. Fig. 1, then, is essentially a time-history of that portion of the detonation front seen by the fine slit as the front proceeded up the tube. The trace starts at the left with a band of high luminosity caused by the initiating explosive (composition *B*), and numerous dark-waves can be seen later in time as the detonation front approaches the region of good focus. The detonation continued for 6 in., which was the full length of the tube, in spite of the dark-waves.

Fig. 2 shows a similar trace obtained from a detonating mixture of 84 per cent nitromethane – 16 per cent acetone (percentage by volume) confined in a brass tube of 0·500-in. internal diameter. Initially, the liquid explosive was at a temperature of 23° C. The rotating mirror was operating here at 5,000 rev./sec., which corresponds to a writing speed of 9 mm./μsec., and a 0·2 mm. slit was used. The dark-waves seen in this weakened explosive are characteristically finer and more numerous. They appear to originate at the tube walls and to advance into the detonating liquid at a lateral velocity of about 4 mm./μsec. Again, this detonation is a stable one which will proceed indefinitely at a constant velocity.

Dark-waves have also been observed in detonating diethylene glycol dinitrate, ethyl nitrate, and single crystals of PETN. It is very likely that they are characteristic of finite-diameter, detonating, homogeneous explosives. They appear to be more prevalent at smaller diameters, weaker confinement and lower

initial temperatures. The dark-waves can become so numerous and large as to cause abrupt failure of detonation. The evidence as a whole suggests that dark-waves are closely associated with hydrodynamic rarefactions originating at charge boundaries.

An interesting effect observed in connexion with dark-waves is that very thin metal foils can considerably reduce the diameter at which failure of detonation of nitromethane occurs and often completely prevent the occurrence of large dark-waves. Fig. 3 shows a camera trace obtained from a glass tube of less than failure-diameter, the first 2 in. of which have been lined with 0·002-in. stainless steel foil. The rotating mirror was operating at 1,000 rev./sec. and a 0·05-mm. slit was used. It can be seen that the detonation is propagated in the foil-lined region and then cut off sharply as it travels beyond the foil. Other experiments have shown that tungsten foil is more effective than steel, and steel is more effective than 'Dural' in reducing the failure diameter of nitromethane in glass. The denser foils are effective in thicknesses less than 0·001 in. The fact that these very thin foils can prevent dark-waves and failure suggests that either the reaction zone in nitromethane is extraordinarily thin or that the foils are effective in allowing the important first step of the reaction to start (and perhaps proceed for a short time) undisturbed by edge effects. Other experiments do, indeed, suggest that the detonation reaction in nitromethane proceeds in several distinct steps[2].

Further work is in progress on these subjects and we plan to publish additional details shortly. The work was done under the auspices of the U.S. Atomic Energy Commission.

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The Cubic Form of Ice

Electron diffraction experiments have been carried out on deposits formed by water vapour on a base at low temperatures. The water vapour is produced in a separate injection unit outside the camera. The object of the experiments was to study, in particular, the diamond-type cubic form of ice observed by König[1] in deposits formed at low temperatures from the residual vapour in an electron-diffraction camera.

The cubic form was found by König to transform on heating into the normal hexagonal structure of ice at about − 80° C. These experiments were of the transmission type, which means that the ice layers can scarcely have been more than a few thousand angstroms in thickness. Experiments by Tschudin[2] on the free evaporation of massive ice in vacuum show, however, that at − 80° C. a layer of ice should be diminishing in thickness at a rate of at least three thousand angstroms a second. It would appear, therefore, that there is some form of contamination which effectively prevents evaporation. In view of the theoretical importance of a new form of ice at zero pressure, it was thought worth while to check the existence of this structure, using a method which allowed the supply of water vapour to be controlled. This was achieved by immersing the water in the injection unit in a bath, the temperature of which could be varied but was usually set at − 78° C.

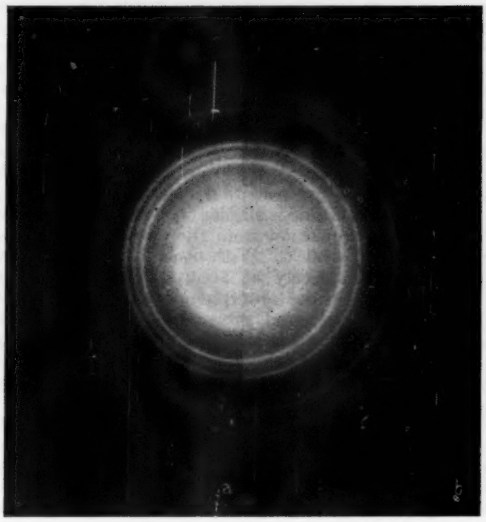

Fig. 1. Transmission patterns of ice: (*a*) hexagonal ice; (*b*) cubic ice

The deposits were formed on a base in a special low-temperature unit which fitted into an existing electron-diffraction apparatus. The unit is essentially a liquid-air jacket containing channels for the electron beam and for the water vapour from the injection unit. The specimen carrier is mounted on a brass disk which is connected both to a heater unit and to the liquid-air container. The temperature of the specimen can be varied from − 180° C. to room temperature.

Three types of diffraction patterns were found with the injection technique depending on the temperature of the base (see Table 1 and Fig. 1). The bases used in transmission experiments were: 'Formvar', collodion, silica, amorphous germanium. In reflexion experiments, cleaved galena was sometimes employed; the usual bases were, however, films of silver formed by evaporation on to heated mica. These have flat surfaces and give a diffraction pattern characteristic of a single crystal.

The same types of deposit were obtained as those found by König, though the characteristic temperature ranges are considerably different. This is in part due to the fact that the deposits in König's work were formed at very low temperatures and then heated. When similar experiments are carried out using the injection technique, the diffuse ring pattern changes on heating into the diamond-type cubic pattern at about − 115° C., the transition taking

Table 1. Injected Water Vapour

Temperature of base	Diffraction pattern	Comments
− 180° to − 140° C.	Diffuse rings	—
− 140° to − 120° C.	Sharp rings	Diamond-type cubic
> − 100° C.	Sharp rings	Hexagonal ice
> − 105° C.		Rapid evaporation

place in a temperature range of about 2 deg. C. The deposit evaporates completely at − 105° C. These results differ from those found by König in two respects. The transition point is substantially higher and better defined, and the layer evaporates completely at a much lower temperature.

To examine this point, deposits were formed from residual vapour in the camera, this being possible if the pumping period is not as prolonged as usual. When 'Formvar' or collodion was used as a base, results were obtained similar to those of König, including the transition from the cubic to the hexagonal form at − 80° C. With other bases, the layers evaporated completely at about − 105° C.; these bases were silica and amorphous germanium in the transmission work and silver in reflexion experiments. These and other experiments suggest strongly that the tenacious character of the deposits is associated with some contamination, which in its turn is associated with the organic bases.

The spacing of the cubic ice was measured at − 120° C., using thallium chloride and rocksalt as standards, the known spacings at room temperature being extrapolated to − 120° C., using expansion data at room temperature, Grüneisen's law and specific heat data.

The cube spacing of the diamond-type form of ice is found to be 6·351 ± 0·007 angstroms, at − 130° C., a value which is slightly lower than that found by König.

Experiments were also carried out using heavy water (of purity 99·72 per cent). The same three types of deposit were found as for ordinary water, the temperatures involved being only a few degrees higher than those characteristic of ordinary water.

The work described above has been made possible by grants from the Department of Scientific and Industrial Research and the Rockefeller Foundation. It is part of an interdepartmental programme organized by Dr. B. J. Mason, of the Meteorology Department of this College.

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Symmetry of Azulene Crystals

The problem of the symmetry of azulene crystals was first put to me by Dr. H. H. Günthard[1] in 1949. He gave me some of the material from which I prepared, by sublimation, extremely pleochroic crystals.

The crystals showed the forms {001} and {110}, but in addition every crystal showed one, and only one, form of the plane (100). In other words, one acute corner of every diamond-shaped crystal was truncated. This seemed to me a strong indication that there was no axis of symmetry and that the space group was Pa and not $P2_1/a$. It is interesting to find from the communication of Prof. J. M. Robertson and Dr. H. M. M. Shearer[2] that X-ray statistical tests confirm the indications of classical crystallography.

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Geometrical Isomerism of some Nitrophenylhydrazones of Benzoyl Formic Acid and their Infra-red Spectra

Recently, papers[1,2] have appeared describing *cis*- and *trans*-2 : 4-dinitrophenylhydrazones of some aliphatic α-keto acids. The structural assignment of the hydrazones as geometrical isomers was confirmed by means of infra-red spectra. Previously[3] we separated 2 : 4-dinitrophenylhydrazone of benzoyl formic acid into two forms, using a salting-out process, and found that the *trans*-form is changed into the *cis*-form by sunlight.

We have now investigated further this hydrazone, as well as mono nitrophenylhydrazones of the acid; it was found in each case that the *cis*-form sodium salt, from the isomeric mixture, could also be precipitated by salting-out with sodium carbonate. Each *cis*-isomer had a higher R_F value (on a silica gel chromato-strip[4] buffered by sodium phosphate), a longer $\lambda_{max.}$ and a lower melting point (except for the 2 : 4-compound). These constants and infra-red data agree well with Isherwood's results[1] (Table 1). All these isomers were isomerized in carbonate solution, or by sunlight or heat.

Separation of the geometrical isomers. Well-powdered hydrazones (2 gm.) were suspended in about 80 ml. of $N/2$ carbonate solution, and various amounts of anhydrous sodium carbonate (0, 1·5, 3, 7 gm.) were then added for the 2 : 4-dinitro-, *o*-, *p*- and *m*-nitro compounds respectively. The precipitated salt (*cis*-form) was washed with carbonate solution. The filtrate was promptly precipitated with hydrochloric acid, and a pure *trans*-form was obtained by recrystallization from methanol with a small amount of acetone. To obtain a pure *cis*-form, the precipitated salt was dissolved in luke-warm water, and again precipitated by the addition of carbonate, and freed from sodium. Purification was by recrystallization from a mixture of methanol and benzene. The 2 : 4-dinitro compound was the most sharply separated. Solubilities of sodium salt of this *cis*-form (having 3·5 moles of water) in water and in normal sodium carbonate solution were 0·82 gm./l. and 0·01 gm./l., respectively. The isomer is sensitive to both light and heat.

Isomerization of the isomers. Isomerization was carried out in alcoholic aqueous solution, with or without addition of carbonate. Such solutions were either left in the sunlight or in the dark. Isomerization and decomposition were traced by studying, spectrophotometrically, the variations of $\lambda_{max.}$ and extinction. In carbonate solution, *m*-isomers were isomerized more distinctly, and accompanied by distinct decomposition. The transformation equilibria (starting from both forms) occurred at two different points according to whether the solutions were in the dark or in the light. This may indicate that isomerization occurs in ionic and in photochemical radical processes concurrently. Other isomers, however, isomerized rather slowly under the same conditions. Contrary to the *m*-isomer, the equilibria of the *o*- and *p*-isomers were at nearly the same respective points. The dinitro-compound, on the other hand, was completely converted into a *cis*-form, without decomposition. After exposure to sunlight, from a concentrated solution of the pure *trans*-form of this compound with carbonate, both forms were actually obtained almost quantitatively. Reverse isomerization could not be effected under alkaline or acidic conditions.

Table 1. Constants of some Phenylhydrazones of Benzoyl Formic Acid and some Infra-Red Spectral Bands

Hydrazones of benzoyl formic acid	Melting point (° C.)	R_F	$\lambda_{max.}$* (mμ)	$\epsilon_{max.}$* (× 10^3)	Infra-red spectral bands (microns)† Finger print region	CO-stretching bands	NH-stretching bands
2 : 4-Dinitro-*cis*	202	0·6	393	26	9·99w	5·96s	—
2 : 4-Dinitro-*trans*	197	0·4	372	24	9·80m	5·91s	3·07w
o-Nitro-*cis*	180	0·4	451	9·2	9·94w	5·96s	3·13–3·16w
o-Nitro-*trans*	203–204	0·2	436	6·8	9·79m	5·85s, 5·95s	3·07w
p-Nitro-*cis*	183	0·4	412	33	9·97w	5·98s	—
p-Nitro-*trans*	191	0·2	393	25	9·79m	5·93s	3·07w
m-Nitro-*cis*	181	0·4	329	21	9·93w	6·01s	3·09w
m-Nitro-*trans*	192	0·2	308	22	9·79m	6·02s	3·08w
Phenyl-hydrazone of benzoyl formic acid (*cis*)					9·96w	6·05s	—
2 : 4-Dinitro-phenyl-hydrazone of meso-oxalic acid					—	5·81s, 5·86s, 5·99m	—

* In alcoholic aqueous solution. † s, strong; m, medium; w, weak.

Infra-red spectra of various phenylhydrazones of benzoyl formic acid and of mesoxalic acid. The infra-red spectra were all obtained with the substances in a paraffin mull. A Perkin–Elmer Model 21 spectrometer fitted with a rocksalt prism was used.

The spectra of all *trans*-forms of the four nitrophenylhydrazones of benzoyl formic acid were characterized by the appearance of weak and sharp absorption bands in the region 9·79–9·80μ. On the other hand, all *cis*-forms of these compounds showed medium bands in the 9·93–9·99μ region. With the phenylhydrazone (which is not separable into two forms), a band appeared in the same region as that of the *cis*-form. In the case of the 2 : 4-dinitrophenylhydrazones of mesoxalic acid, as well as of pyruvic acid (observed by T. Moriwaki[2]), there were no distinct bands in these regions.

In the case of the chelated *cis*-isomers, with the exception of the *m*-nitrophenylhydrazones, the strong carbonyl bands appeared in the longer wave-length region as with those of aliphatic acid derivatives, the original shorter wave-length bands of which almost disappeared. The obscure imino bands became more obscure (Table 1).

I am grateful to Profs. R. Nodzu and R. Gotō, of Kyoto University, for their helpful suggestions. The use of the Perkin–Elmer instrument was made possible through the courtesy of the Sumitomo Chemical Co., Ltd., in Osaka.

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Formation of Free Radicals in Polymer Films on Irradiation

It is known that free radicals may be formed in rigid solvents[1–3], and that during the polymerization of acrylonitrile they may become trapped in the polymer[4]. The relative stability of the radicals under these conditions probably accounts for the instability of cellulose observed[5] after exposure to ultra-violet radiation. We have recently been studying the action of light on dyed and undyed films and some of our results are of interest in connexion with the recent observations of Ford[6]. In the course of our work, undyed films of cellulose acetate (deplasticized, British Celanese), nylon (no plasticizer, hexamethylene diamine – adipic acid, 0·004 in. thick, Du Pont de Nemours) and methylmethoxy nylon (no plasticizer, Imperial Chemical Industries) have been exposed to the effect of heat and/or radiation.

Our results with these films can be summarized briefly: (1) The absorption spectra of the unexposed films are not appreciably changed on heating in either oxygen or nitrogen in the dark at 50° C. for 150 hr. (2) After prolonged exposure in either gas to a high-pressure mercury-vapour lamp (G.E.C., Osram) only slight changes in absorption spectra are found either immediately after exposure or after storage in the dark at room temperature or at 50° C. (3) On exposure to a low-pressure mercury lamp emitting mainly at 2537 A., profound changes are produced in the films. These changes are (*a*) an effect shown immediately after exposure, and (*b*) a post-irradiation effect, which appears on storage in the dark and is greater on storage at higher temperatures.

The latter experiments were carried out in quartz absorption cells, and streams of dry nitrogen (oxygen-free) or oxygen were passed through them continuously throughout the experiment. Fig. 1 illustrates the changes with nylon film. After exposure for 20 hr. the peak in the unexposed film at 2800 A. is displaced to 2900 A. and is considerably increased. On heating in the dark at 50° C. for 300 hr. the peak reverts to about 2850 A. and is further augmented. This change occurs in both oxygen and nitrogen, and would seem to exclude the suggestion made by Ford[6] that the change in nylon films on irradiation is due to combination with oxygen. This may possibly occur to some extent during irradiation in oxygen; but the similarity of the results in oxygen and nitrogen suggests that the full explanation is likely to be much more complex. Other workers[7,8] have observed the development of a band in the region of 2800–2900 A. on the heating of nylon at high temperatures in a vacuum, and it may be that the products formed on irradiation and on pyrolysis resemble one another.

After an exposure of 5 hr. it was observed that in nitrogen (but not in oxygen) the peak at 2800 A. in the unexposed nylon film was depressed and flattened immediately after irradiation, although after heating in the dark for 300 hr. at 50° C. the curves in both oxygen and nitrogen were beginning to show the trend displayed prominently in Fig. 1, that is, peaks in the region of 2850 A. It seems likely that the changes in absorption spectra are due to slow recombination of trapped free radicals formed by photolysis either with themselves or by a series of complex reactions with the polymer chain itself.

The results obtained with cellulose acetate film show one very interesting feature. Immediately after irradiation the increase in optical density of film exposed

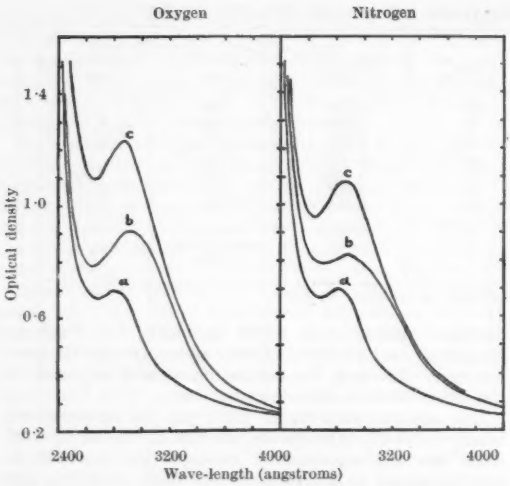

Fig. 1. Nylon film exposed to low-pressure mercury-vapour lamp: (*a*) unexposed; (*b*) immediately after 20 hr. exposure; (*c*) heated for 300 hr. at 50° C. after exposure

in dry nitrogen is greater than that exposed in oxygen, the difference apparently being greater the longer the period of exposure. It is thus not possible to ascribe such changes purely to reaction with oxygen. Methylmethoxy nylon films, which have no absorption peaks before exposure, are highly unstable to short-wave ultra-violet radiation. Although the changes are greater in oxygen than in nitrogen, there is some evidence in both gases of the formation of a peak around 2800 A., suggesting that the methylmethoxy group may possibly be split off the polymer chain on irradiation. Substantial changes occurred with these exposed films on heating at 50° C. for 300 hr.

There seems to be one important conclusion from this work which has a bearing on the related subject of the action of near ultra-violet and visible light, such as is present in sunlight, on textile materials. There is substantial evidence[9] that this phenomenon is completely different in mechanism from the photolytic effect of 2537 A. radiation. The results with the undyed films suggest that on irradiation with near ultra-violet and visible light no trapped free radicals are produced in the polymer material. It thus appears doubtful whether free radicals play any part in the degradation of textile materials which are exposed to sunlight behind glass.

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A Complement-fixing Antigen from Egg-adapted Canine Distemper Virus

The distemper complement fixation test, first used by Laidlaw and Dunkin[1] for measuring the antibody content of hyperimmune dog serum, has not been extensively employed in studies on this disease. These authors, together with Pyle and Brown[2], Mansi[3,4] and Hudson and Mansi[5], have all used relatively crude suspensions of infected dog tissue as antigen. The one attempt to demonstrate complement fixation antigen in various chick embryo tissues subsequent to infection with egg-adapted viruses was unsuccessful (Mansi[4]).

Preliminary experiments with the Onderstepoort egg-adapted distemper strain (190th chorioallantoic membrane passage) showed that virus-rich chorioallantoic membrane was able to fix complement in the presence of both distemper-immune and normal dog sera. This latter non-specific reaction was, however, greatly reduced following adsorption of the crude chorioallantoic membrane material with a strongly basic anion-exchange resin, 'Dowex-1'. A subsequent period of heating at 56° C. for 15 min. completely abolished non-specific activity without adversely affecting antigenicity. The procedure now to be described repeatedly yielded satisfactory complement fixation antigens.

Five days after inoculation of chorioallantoic membrane with a high concentration of seed-virus, grossly infected areas were removed and ground in a blender to form a 50 per cent (w/v) suspension in Kolmer saline (100 mgm. $MgCl_2.6H_2O$ in 0·85 per cent NaCl). The crude suspension was clarified by slow-speed centrifugation and then adsorbed for 30 min. at room temperature with an equal volume of 'Dowex 1*x*–10' resin (the adsorbant previously being converted to the sodium form with 10 per cent disodium hydrogen phosphate and repeatedly washed in distilled water). Following centrifugation, the supernatant fluid was removed and heated at 56° C. for 15 min. and finally titrated against immune dog serum by the 'chessboard' method to determine the optimal antigen concentration for routine use (usually a 1 : 2 or 1 : 4 dilution of stock material).

Antigens prepared by the above method were not anticomplementary, did not produce a precipitate when stored in the fluid state at 4° C., and when used with a 'short' fixation time (1 hr. at 37° C. prior to the addition of sensitized red cells) did not show the false positive reactions which often occurred following overnight ice-box fixation. Contrary to the observation of Mansi[4], it was found essential to inactivate at 56° C. for 30 min. all dog and ferret sera prior to testing, since unheated sera were invariably procomplementary and yielded false negative results. Using the above method, distemper-immune dog sera complement fixation titres of the order of 1 : 32 to 1 : 48 (50 per cent fixation end-point) were regularly obtained, while sera from young 'normal' puppies failed to react in a dilution of 1 : 5. It is of interest to record that these former sera when diluted 1 : 250 to 1 : 500 and mixed with approximately one hundred egg-infective doses of virus completely suppressed lesion formation on the chorioallantoic membrane. The negative sera in the lowest dilution tested (1 : 10) did not prevent virus growth.

Incidental observations made on the distemper antigen produced from chorioallantoic membrane suspensions showed the 'Dowex'-adsorbed material to be virtually inactive after heating for 30 min. at

56° C. Antigenicity was, however, completely retained at this temperature during the 15 min. necessary for the abolition of non-specific reactions with normal dog sera. Several unsuccessful attempts were made to prepare satisfactory antigens from crude chorio-allantoic membrane suspensions by precipitation either with methanol (30 per cent final concentration) or with protamine sulphate (0·5 per cent). These results will be reported on in detail at a later date.

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Influence of Ionizing Radiation on the Appearance in the Serum of Rabbits of Humoral Factors slowing down Cell Division

Work was undertaken to study certain physiological mechanisms which play a part in the reaction of higher organisms to ionizing radiations. I wish to record the finding in the serum of irradiated animals of a humoral factor that influences the rate of cell division. Experiments of a similar nature have been reported by other workers[1], who found, however, no or uncertain effects of humoral factors.

Rabbits received a single dose of whole-body X-irradiation of 900 r. (focal skin distance 90 cm., 190 kV., 12 m.amp., 0·5 mm. copper, dose-rate 20 r./min.). Blood was obtained by cardiac puncture 24 hr. after irradiation of the animals. Simultaneously and by the same procedure, blood was obtained from controls. Heart fibroblasts of chicken embryos were cultured quantitatively in roller tubes, using, with minor adjustments, the method described by Hull *et al.*[2]. 4 ml. of serum of irradiated rabbits or controls with the addition of 50–100 μc. of radiophosphorus as acid sodium phosphate dissolved in 0·1 ml. saline were used as culture medium. Growth, as indicated by the daily increment of the radioactivity of the culture, was determined daily for periods of about ten days; in later experiments, cultivation was discontinued after five daily measurements.

The reproducibility of growth-curves, as determined by the above-mentioned technique, was established in forty experiments, using identical serum in duplicate or triplicate cultures. The probable error in these experiments was about 10 per cent. The significance of the difference in growth-rate observed between tissue cultures grown on serum of irradiated rabbits and on serum of controls was tested by Fisher's *t*-test using the results of thirty-one experiments (fifteen irradiated, sixteen controls). The results show that tissue cultures grow more slowly on the sera of irradiated rabbits than on the sera of controls, the difference being about 30 per cent. This difference was statistically highly significant ($P < 0{\cdot}01$).

In further experiments, serum of irradiated or control sabbits respectively was added to the standard fluid medium and infected with a standardized suspension of *E. coli* (9 ml. standard medium + 3 ml. serum + 0·1 ml. standard suspension of *E. coli* in saline). Growth of the culture was evaluated by the turbidimetric method, using in early experiments a Coleman Junior spectrophotometer. Measurements were carried out at 650 mμ. In later experiments, the automatic recording photocolorimeter described by Marha and Jenšovský[3] was used.

To compare growth-rates, the values of $t_{1/4}$, $t_{1/2}$ and $t_{3/4}$ were determined. These values indicate the time necessary for the number of organisms, and so the turbidity of the culture, to reach one-quarter, one-half and three-quarters of the maximal value.

As in the case of our experiments with quantitative tissue cultures, the reproducibility of results using identical sera in duplicate or triplicate experiments served as a measure of the error of the method. A probable error of 2 per cent was obtained in our experiments, indicating that the method is well reproducible.

Table 1 shows the mean relative $t_{1/4}$, $t_{1/2}$ and $t_{3/4}$ for *E. coli* cultures using standard medium, standard medium with the addition of serum of controls and standard medium with the addition of serum of irradiated rabbits.

Table 1

Medium	Relative $t_{1/4}$	Relative $t_{1/2}$	Relative $t_{3/4}$
Standard medium	1·0	1·0	1·0
Standard medium + serum of controls	1·32	1·33	1·31
Standard medium + serum of irradiated rabbits	1·64	1·63	1·58

All the differences shown in Table 1 are statistically highly significant ($P < 0{\cdot}01$).

These experiments lead to the conclusion that the addition of rabbit serum to the standard medium decreases the growth-rate of *E. coli*. On addition of serum of irradiated rabbits, the growth-rate decreases still further. On analysing the growth curves, we find that the decreased growth-rates are caused by the prolongation of the initial stationary phase of the cultures.

In further experiments we have shown that when rabbit blood or rabbit serum is irradiated *in vitro*, it does not influence the growth-rate of *E. coli*, if added to standard culture medium. In order to produce this effect, the whole organism has to be irradiated.

In addition it was found that the factor responsible for hampering cell division is thermolabile, that it can be inactivated by heating to 56° C. for 30 min.; further, it was found that it does not pass through ultrafilters. On coagulation of the serum proteins at low temperature with an ether–alcohol mixture, the humoral factor stays in the coagulum. On dialysing the serum, the dialysate and the euglobulin fraction showed no influence on the growth-rate of *E. coli*. The pseudoglobulin and albumin fraction, however, prolonged the initial stationary phase of *E. coli*. On incubation of the serum for 1 hr. at 37° C. with *E. coli* killed by heating to 65° C. for 1 hr., the serum loses most of its depressing effect. Similar results are obtained on incubating the serum with a cellular suspension of calf thymus. Incubation of the serum with dead micrococci without toxic components typical of staphylococci, or with dead air-borne bacilli anthracoides, causes loss of ability of the serum to depress the growth of *E. coli*.

The experiments described prove, therefore, the existence of a humoral factor slowing down cell division on the serum of rabbits. The effect of this factor increases after irradiation of the rabbit. The fact that irradiation of blood or serum *in vitro* with doses of irradiation used in these experiments does not increase the ability of the serum to slow down growth of tissue cultures or *E. coli* indicates that this effect is not due to physico-chemical changes caused directly by the effect of ionizing radiation on the serum proteins, as assumed by Woenckhaus[4] and Žáček[5]. The whole organism must be irradiated to achieve this effect.

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Probable Identity of an Antibiotic produced by a Spore-bearing Bacillus of the *B. pumilus* Group with Micrococcin

The production of an antibiotic by a species of *Micrococcus*, isolated from Oxford sewage, was reported by Su[1], who named the substance micrococcin. Later, Heatley and Doery[2] gave an account of the preparation and some of the properties of purified micrococcin. They showed it to be relatively insoluble in water, to darken and sinter at 222–28° without having a sharp melting-point, to show a maximum in its ultra-violet light absorption spectrum in ethanol at 345 mμ (*E* 1%, 1 cm., 180), to have $[\alpha]_D^{20}$ + 116° (*c*, 5·0) in 90 per cent ethanol, molecular weight greater than 2,000, and to give the following elementary analysis: C, 49–49·5; H, 4·6; N, 13·9; S, 15·9 per cent. They also stated that "it gives a positive ninhydrin reaction only after acid hydrolysis, but this seems to be due to ammonia, not amino-acids. Nothing is known of its chemical nature". Still later, Fuller[3] isolated from cultures of a spore-bearing bacillus of the *B. pumilus* group, originating in soil collected in East Africa, an antibiotic, sparingly soluble in water, which became discoloured at 232°, sintered at 238°, and appeared to melt at 252°; it gave the following elementary analysis: C, 48·9; H, 4·7; N, 13·7; S, 16·0 per cent. It did not appear to give a ninhydrin test even after hydrolysis with hydrochloric acid and was thought to be of non-peptide nature.

The similarity in the properties of the antibiotics from these two widely divergent sources suggested that they might indeed be related in structure, and, in the interval, some progress[4] had been made with the study of the chemistry of the antibiotic obtained from *B. pumilus*, which had been found to have a maximum in its ultra-violet light absorption spectrum in 95 per cent ethanol at 345 mμ (*E* 1%, 1 cm., 210) and to have $[\alpha]_D^{20}$ + 63·7° (*c*, 1·19) in 90 per cent ethanol. On acid hydrolysis it broke down to give a series of compounds, conveniently considered in two groups, (i) soluble, and (ii) insoluble, in the cold diluted hydrolysis mixture. Continuous ether extraction of the acid-soluble fraction afforded a substance, $C_7H_7O_3NS$, and propionic acid, leaving still a complex mixture of substances, while treatment of the insoluble material with methanolic hydrogen chloride gave a non-basic substance, $C_{24}H_{22}O_6N_6S_4$, and a substance, $C_{16}H_{19}O_3N_3S_2$ (?), isolated as the picrate. Further examination of the water-soluble fraction left after removal of the substance $C_7H_7O_3NS$ showed it to contain ammonia in amount corresponding to about 23 per cent of the total nitrogen present in the antibiotic (micrococcin, 24·2 per cent[3]), and paper chromatography in butanol/acetic acid/water (63 : 10 : 27) revealed the presence of four ninhydrin-reacting substances giving spots of R_F about 0·20 (violet), 0·26 (yellow) forming a cap to another spot of R_F 0·32 (violet), and 0·52 (violet). Ion-exchange chromatography on 'Amberlite *IR*-120(H)' afforded the first and fourth of these ninhydrin-reacting substances in pure form. The slowest-running substance in the paper chromatography came off the resin first in *N* hydrochloric acid and proved to be L-threonine, while the fastest-moving substance in the paper chromatography left the resin last in 3 *N* hydrochloric acid and was a substance, $C_8H_{12}O_2N_2S$, isolated as the hydrochloride.

After acid hydrolysis of micrococcin, earlier carried out in Oxford, the same pattern of ninhydrin-reacting substances was shown on paper chromatography as that observed for the antibiotic from *B. pumilus*, and the two antibiotics have now been found to possess very similar infra-red absorption spectra and comparable fluorescence characteristics. In addition, redetermination of the optical rotatory power of micrococcin at lower concentration than that previously used[3] has given $[\alpha]_D^{20}$ + 62·2° (*c*, 1·10) in 90 per cent ethanol, and the substances $C_7H_7O_3NS$ and $C_{24}H_{22}O_6N_6S_4$ have now both been isolated after acid hydrolysis of micrococcin, so that a considerable degree of identity, or near-identity, between the antibiotics from the two sources has been demonstrated. However, with substances of such a degree of complexity as these one cannot be confident that they are identical in every detail, and it is still possible that, as in other cases among antibiotics, we have in these two substances two members of a group of closely related compounds. As the name 'micrococcin' is already established in the literature, it may be undesirable to apply a specific trivial name to the antibiotic produced by *B. pumilus* in view of the

Table 1

Test organism	Minimal inhibitory concentrations (μgm./ml.) in nutrient broth	
	Micrococcin	Micrococcin *P*
Bacillus cereus	0·05	0·05
Bacillus laterosporus	0·03	0·01
Bacillus firmus	0·4	0·4
Bacillus mycoides	0·02	0·02
Streptococcus haemolyticus, Group *C*	0·2	0·2
Streptococcus faecalis	0·05	0·05
Staphylococcus, Group *B*	0·07	0·07
Staphylococcus aureus "13"	2·0	2·0
" " "21"	0·2	0·5
" " "23"	0·5	1·0
" " "24"	5·0	5·0
Leuconostoc citrovorum	0·02	0·01

The strains of *Staphylococcus aureus* had been isolated from hospital cases and were kindly provided by Dr. Mary Barber, Department of Bacteriology, St. Thomas's Hospital. Strains "13" and "21" were resistant to penicillin, streptomycin and oxytetracycline, while strain "23" was resistant to penicillin; strain "24" was sensitive to penicillin, streptomycin and oxytetracycline.

relationship between the two antibiotics that has emerged. On taxonomic grounds, however, the term 'micrococcin' is too narrowly suggestive of source to be satisfactory as a name for the antibiotic from *B. pumilus*; but, in the circumstances, it may serve as a chemically generic name, and we propose to refer to the antibiotic obtained from *B. pumilus* as 'micrococcin *P*', in the absence of evidence to show that the two substances are completely identical. As Table 1 shows, the antibacterial 'spectra' of the two substances were very similar, and organisms made resistant to one antibiotic were resistant to the other in comparable degree.

An account of the chemistry of micrococcin *P* will appear elsewhere[4].

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Intra-cellular Identification of the Rous Virus

It has recently been established by an electron microscopical survey that the incidence of tumour cells with virus-like particles 70 mμ in diameter varied widely in the tumour-cell populations of different examples of Rous ascites tumours[1]. In view of the manifest impossibility of equating unknown particles with virus on morphological grounds alone, further experiments have been made in which morphological studies were combined with biological tests.

A sample of ascitic fluid was taken from each of five Rous ascites tumours and the number of tumour cells in it was determined using a hæmocytometer. Each sample was divided into two portions. The first portion was used to make electron microscope preparations by the method employed in the earlier work[2]. This method allows all the cells in a sample to be examined as well as the whole of each cell, and thus makes it possible to establish the incidence of tumour cells with particles in the total tumour-cell population. To do this, 3,000 cells from each tumour were searched in the electron microscope.

The cells in the second portion of each sample were collected by centrifugation, washed six times by centrifugation and then disrupted under standard conditions in a mechanically driven Ten Broek disintegrator. The virus released from the broken cells was titrated by diluting in serial tenfold steps and inoculating samples of each dilution intradermally in four young pullets. From the number of tumours which developed following the inoculations, that dilution of the virus suspension which would have caused tumours in 50 per cent of the birds was calculated[3]; the result has been expressed in terms of 1 ml. of ascitic fluid containing the cells from which the virus suspension was made and is shown in Table 1 as the 'tumour dilution 50 per cent' (*TD*50).

Fig. 1. Vacuole from a Rous ascites tumour cell showing a group of Rous virus particles; the limiting membrane of the vacuole can also be distinguished, particularly where it has become folded. Fixation over osmium oxide vapour was started after the cell had been *in vitro* for 21 min. and was continued for 30 hr. Electron micrograph, × 20,000

It can be seen from Table 1 that where few tumour cells with particles were found (Exp. 12) the tumour-producing activity of the virus extractable from the cells was low, while where many cells with particles were found (Exps. 10 and 11) this activity was high. The figures between these extremes (Exps. 9 and 13) also show close agreement. Statistically, the correlation is highly significant and $P = 0{\cdot}002$; taken in conjunction with the size of the particles and their appearance, this correlation makes it possible definitely to identify the particles as the Rous virus. From the results obtained it has also been possible to show that something of the order of 50 virus particles were the average minimum number needed

Table 1. Correlation between Incidence of Rous Ascites Tumour Cells with Particles in Total Tumour-Cell Population and Infectivity of Virus Extractable from the Cells

Exp. No.	Tumour cells per c.mm. ascitic fluid	No. of cells examined in electron microscope	No. of cells containing particles	Incidence of cells with particles	No. of cells with particles per ml. ascitic fluid	*TD*50 per ml. ascitic fluid
9	23,000	2,997	6	1/500	46,000	$10^{-5\cdot3}$
10	24,000	3,003	40	1/75	320,000	$10^{-6\cdot4}$
11	26,000	3,000	52	1/57	456,000	$10^{-6\cdot1}$
12	18,000	3,000	1	1/3,000	6,000	$10^{-4\cdot1}$
13	29,000	3,000	16	1/187	155,000	$10^{-5\cdot8}$

to cause a tumour under the experimental conditions used.

As in the earlier work[1], the virus particles have only been observed grouped together in association with the vacuoles which are commonly found in Rous ascites tumour cells. So far, 27,637 such cells, with their fine structure well preserved, have been examined in the electron microscope, and 168 of them have contained virus particles. In no single instance has the virus been observed lying free in the cytoplasm. The vacuoles have been found to have a limiting membrane; such a membrane can be seen around the vacuole shown in Fig. 1, particularly where it has become folded. A group of virus particles is also present.

A detailed account of this work is to be given elsewhere[4], together with a discussion of its significance and its relation to reports of unidentified particles in fowl cells, both from normal chick embryos[5] and from Rous tumours[6].

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Effect on the Growth-rate of Weanling Rats of supplementing the Protein of White Bread with *l*-Lysine

We have recently re-investigated the rates of growth of rats, of both sexes and at various ages, on diets in which all the protein was derived from white flour (70 per cent extraction) or from wholemeal. The stimulus for this re-examination was provided by the publication by Widdowson and McCance[1] of their results of the growth of both children and animals on diets containing a large proportion of wheaten flour. Our experiments have shown[2] that the superior growth-rate of male weanling rats on the protein of wholemeal, compared with that of white flour, is due to the higher lysine content of the wholemeal protein. This work also demonstrated the extreme sensitivity of the weanling rat to small changes in the lysine content of the diet, when wheaten flour is providing the protein. We have accordingly now investigated the growth response of male weanling rats when small increments of *l*-lysine were added to a diet in which the protein was provided by white bread. Similar experiments have been carried out by Rosenberg and Rohdenburg[3], Rosenberg, Rohdenburg and Baldini[4] in the United States; but the bread used contained 3 per cent non-fat milk solids.

This type of experiment was of additional interest since it is known that, with certain diets, an increase in the content of a single amino-acid may lead to a reduced rate of growth through inducing an amino-acid imbalance. This effect, and the related problem of antagonism between certain individual amino-acids, have been extensively investigated by Elvehjem and co-workers, and a paper[5] by the Wisconsin workers gives a comprehensive list of references to earlier work. The results we have obtained are given in Table 1.

Table 1. Response to the Addition of *l*-Lysine to a Diet in which the Protein was supplied by White Bread Crumb
(Growth of male rats measured over 28 days from weaning)

Lysine addition (per cent)	Nitrogen in diet (per cent)	Mean weight gain per rat per day (with 95 per cent fiducial limits)	Mean food intake per rat per day (with 95 per cent fiducial limits)	Ratio of weight gain to intake of nitrogen
0·0	2·15	1·2 gm. ± 0·2	7·4 gm. ± 0·5	7·8
0·06	2·16	1·9 gm. ± 0·2	9·1 gm. ± 0·5	9·5
0·12	2·17	2·3 gm. ± 0·2	9·2 gm. ± 0·5	11·4
0·18	2·19	3·0 gm. ± 0·2	11·0 gm. ± 0·5	12·4
0·24	2·20	3·4 gm. ± 0·2	11·3 gm. ± 0·5	13·7
0·30	2·20	3·3 gm. ± 0·2	11·1 gm. ± 0·5	13·6

The diet was adequately supplemented with vitamins and minerals. It contained 80 per cent by weight of white bread, 5 per cent arachis oil and the balance sucrose.

From Table 1 it will be noted that the optimum response was provided by the addition of about 0·25 per cent *l*-lysine. The lysine content of the unsupplemented diet measured by the Moore and Stein technique[6], using the ion-exchange resin, 'Zeocarb 225', was 0·25 per cent. Thus the best growth-rate was obtained at a lysine content of about 0·5 per cent.

An earlier experiment, with five lysine supplements increasing from 0·2 per cent, by increments of 0·1 per cent to 0·6 per cent, had also shown that the optimum response in growth-rate (again 3·4 gm./rat/day) was reached with a lysine addition between 0·2 and 0·3 per cent. There was an indication of a slight fall (only just significant at $p = 5$ per cent), in food consumption and in gain in weight, with the lysine addition of 0·6 per cent. It was therefore of interest to ascertain whether the addition of a still greater quantity of lysine would depress the growth-rate by inducing an amino-acid imbalance. To test this point the growth-rate with an addition of 0·3 per cent lysine (a level where the plateau for growth-rate had been reached) was compared with that when the supplement was 1·2 per cent lysine. In the first week of this experiment the growth-rate was significantly less at the higher lysine-level (2·8 gm./day as against 3·6 gm./day at the 0·3 per cent lysine-level). But the food consumption was also less. During the following two weeks the difference in rate of gain in weight narrowed, and the results for growth over 21 days are given in Table 2.

At the higher lysine-level the rate of gain was less, but so also was the food intake. The use of a highly significant ($p \sim 0·1$ per cent) linear regression of weight-gain on food-intake indicates that the reduced rate of gain may be wholly accounted for by the reduced food consumption.

One of the most interesting features of these observations is the good rate of growth (3·4–3·6 gm. per rat per day) which is obtained when wheat protein is supplemented by a small addition of lysine.

Table 2

Lysine addition (per cent)	Nitrogen in diet (per cent)	Mean weight gain per rat per day	Mean food intake per rat per day	Ratio of weight gain to intake of nitrogen
0·3	2·36	3·6 gm. ± 0·3	11·2 gm. ± 0·5	13·7
1·2	2·54	3·2 gm. ± 0·3	10·2 gm. ± 0·5	12·5

In this experiment white bread crumb provided 90 per cent by weight of the diet.

The growth-rate is almost trebled compared with that obtained in the unsupplemented bread; an observation which is closely similar to those made by Rosenberg, Rohdenburg and Baldini[4]. It should be emphasized that our observations have only been concerned with growth, and the effect on other aspects of development needs to be investigated.

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Anticoagulant Action of Neodymium 3-Sulpho-*iso*nicotinate

Although it has long been known that the rare-earth metals interfere with blood clotting both *in vitro* and *in vivo*, it was not until 1950 that Vincke and Sucker[1] described, in neodymium 3-sulpho-*iso*nicotinate, a compound that was sufficiently soluble and free of toxic effects for clinical use. It is given by intravenous injection in 2·5 per cent solution and was at first regarded as a prothrombinopenic agent on the basis of a prolonged one-stage 'prothrombin' time. Recently, using newer techniques, Beller and Mammen[2] have reported that neodymium acts by reducing factor VII and factor X, leaving prothrombin normal. We have meantime been studying, independently, the mode of action of this salt, using in particular the blood thromboplastin generation test[3], with the following results.

In intravenous doses of the order of 5 mgm./kgm. in man and rabbits, it led to impairment of intrinsic blood thromboplastin generation by inhibiting, in the circulating blood, two thromboplastin constituents normally present in serum, namely, Christmas factor (*PTC*, factor IX) and factor X[4,5]—and also to reduction in factor VII (*SPCA*, stable factor) activity. It is this action on factor VII (which, it is now recognized, plays no part in blood thromboplastin formation) that is responsible for the prolonged one-stage 'prothrombin' time. These effects were demonstrable in four hours and lasted for twenty-four hours or slightly longer. With this dosage there was no alteration in the antihæmophilic globulin activity of the plasma, and the whole-blood clotting time in glass remained normal. With larger doses of 50 mgm./kgm. in animals, however, in addition to the above effects, the whole-blood clotting time was greatly prolonged and the activity of antihæmophilic globulin was reduced. In neither case was there any interference with prothrombin measured by the two-stage method, or with the thrombin–fibrinogen reaction. The action on factor VII and the serum thromboplastin factors was not prevented by oral premedication in humans with vitamin K_1 in 50-mgm. doses. In fifty-four injections in twenty patients no toxic effects were encountered.

Bergsagel[6] has shown that calcium interacts with Christmas factor at an early stage in the formation of blood thromboplastin. Since calcium and neodymium are similar in their chemical properties but are not, of course, biologically interchangeable, it is possible that neodymium acts as an antimetabolite of calcium by displacing it from combination with one or more of the protein factors in coagulation, although to date we have no evidence that excess of calcium will prevent the action of neodymium *in vitro*.

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Trans-Synaptic Atrophy in the Cerebral Cortex

The disappearance of neurones from the primate lateral geniculate body after de-afferentation has been clearly demonstrated[1], and less dramatic trans-synaptic degenerative changes have been described elsewhere in the central nervous system, for example, in the cortex of the piriform lobe after degeneration of the olfactory tract[2]. Hitherto, however, attention has been focused on the perikaryon, and the role of afferent input in preserving the normal dendritic organization of neurones has apparently never been studied.

We have examined the pyramidal cells in the pre-piriform cortex of the rat after removal of the olfactory bulb, which is known to be the main source of afferent fibres to this region[3]. Comparison of the two sides of rat brains subjected to unilateral olfactory bulb resection has revealed no obvious differences in the nuclei or perikarya of the pyramidal cells, apart from a slight reduction in size, in material stained with buffered thionin, or in the fibre plexuses in material prepared by the Holmes–Silver impregnation technique. In Golgi–Cox preparations, however, a marked reduction in the number of dendritic branches arising from the pyramidal cells on the operated side has been consistently observed during the examination of a large number of neurones in three brains.

This change is very conspicuous a hundred days after operation on forty-day old rats. It is readily observed in the plexiform layer, the second of the five layers into which the pre-piriform cortex has been subdivided[4]. This layer contains the dendrites of the pyramidal cells as they pass to synapse with the axons of the lateral olfactory tract, which spread out over the surface of the piriform lobe. Typical examples of normal and atrophic pyramidal cells that appeared to be completely stained are shown in Fig. 1; their silhouettes were traced under the micro-projector. We conclude that the normal pattern of dendritic organization of the pyramidal cells in the pre-piriform cortex is dependent upon the integrity of their afferent input.

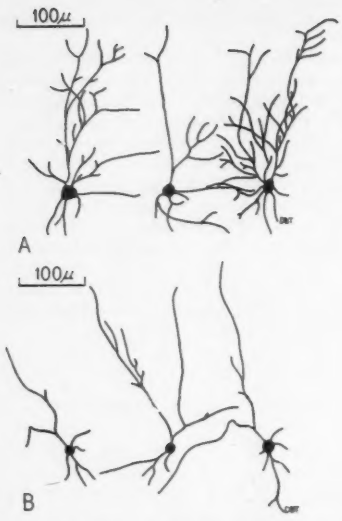

Fig. 1. Pyramidal cell bodies in the pre-piriform cortex of a rat killed a hundred days after unilateral olfactory bulb resection at the age of forty days. *A*, normal side; *B*, side of operation (Golgi–Cox preparation, micro-projector tracing)

Further work is in progress and will be reported elsewhere. We are indebted to Prof. J. Z. Young, who placed the facilities for this investigation at our disposal, for his advice and encouragement.

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The Longevity Function : Some Additional Data from Domestic Animals

In 1825, Benjamin Gompertz[1] analysed the function expressing the law of human mortality and suggested that the rate of mortality increased in a logarithmic manner with the age of the population. Recently, Kershaw, Chalmers and Lavoipierre[2], analysing the pattern of mosquito survival in laboratory conditions, showed that, for a cohort of 1,200, the Gompertz function was linear for both male and female.

Unfortunately, only figures of percentage survival were available for this cohort, and it was desirable to check the function by constructing a life-table. An appeal was therefore made for information on other survival data, published or unpublished, and information was obtained by one of us (J. O. L. K.) on cohorts of 167 draught horses, 63 breeding sows, and on 79 Ayrshire and 82 British Friesian cows. The criterion in these cohorts was economic—the working-life of the horse, the breeding-life of the sow and the milking-life of the cow.

The cohorts, when analysed by the graphic method introduced by Kershaw *et al.*, for numbers near or less than 100, yield a linear Gompertz function. The data on the horses and on the sows, when plotted as a frequency distribution curve of the number of animals against the economic life, show a normal probability curve, and similar curves for each herd of cows show a log-normal distribution.

We have analysed all the data available to us, including information published by the United States Atomic Energy Commission[3], on the survival of mice, guinea pigs and rabbits (the results will shortly be published in detail in the *Annals of Tropical Medicine and Parasitology*); but we have so far been unable to determine why some distributions are normal whereas others are log-normal; nor have we been able to correlate the type of curve with any feature of the biological system involved or with the criterion of survival.

It would appear that the determination of the pattern of mortality of biological systems is of such fundamental importance that all available information should be analysed; we therefore reiterate our appeal for information on survival data.

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Relation between Genetic Constitution of an Offspring and Weight of its Litter-mates

Rabbit does, drawn from a single stock, were artificially inseminated, either from one large buck of the same stock or from one small one of a different strain[1]. The two types of offspring were distinguishable by pre-arranged genetic factors. Offspring of the large buck averaged 2·7 gm. heavier at birth than offspring of the small buck. When they were raised in the same litters, after heterospermic insemination with mixed semen, the difference in birth-weight increased to 6·1 gm. The increase may be called the 'enhancement effect' in relative birth-weight.

This result prompted investigation of a naturally occurring analogue of the experiment. In mammalian dizygotic twin births, there are again two recognizable types of offspring, male and female, whose genetic constitutions carry with them a weight difference, the males being the heavier in most species. Also, the two types of offspring are born either in litters of one type (like-sexed twins), or are born together in the same litters (unlike-sexed twins). Is the difference in birth-weight of the sexes greater in unlike-sexed twins? As shown in Table 1, there is, in fact, an apparent enhancement effect in six sets of data for sheep twins. In the first two sets of data[2], which are unweighted averages, the effect was not found statistically significant by the authors. The small third group, a combination of the control data of three experiments[3–5], also shows an enhancement effect, though not significantly. This group was obtained by listing the four series of births that

Table 1. BIRTH-WEIGHT IN LIKE- AND UNLIKE-SEXED TWINS

	No. of twin offspring	Mean birth-weights per offspring in lb.				Difference in birth-weight of sexes		Measure of enhancement effect (*a*–*b*)
		Unlike-sexed twins		Like-sexed twins		Unlike-sexed twins (*a*)	Like-sexed twins (*b*)	
		♂	♀	♂	♀			
Sheep								
Cheviot (ref. 2)	*c.* 2,200	7·48	7·06	7·28	7·02	+ 0·42	+ 0·26	+ 0·16
Shropshire (ref. 2)	*c.* 2,200	9·37	8·78	9·33	9·04	+ 0·59	+ 0·29	+ 0·30
Various (refs. 3, 4 and 5)	46	9·27	8·16	9·04	8·50	+ 1·11	+ 0·54	+ 0·57
Langhe (ref. 6) (from record abstracts)	212	10·06	9·05	9·36	8·96	+ 1·01	+ 0·40	+ 0·61
Welsh Mountain, 1951–53 } from N.A.A.S.	276	5·78	5·34	5·84	5·45	+ 0·44	+ 0·39	+ 0·05
Welsh Mountain, etc., 1954 } records	150	7·39	6·87	7·07	7·77	+ 0·52	− 0·70	+ 1·22
Man (ref. 7)	72	5·74	5·48	5·53	5·44	+ 0·26	+ 0·09	+ 0·17

contained figures for all four types of offspring; birth-weights were then averaged successively within and between series. The material on the Langhe sheep was calculated from the original record abstracts of Mason and Dassat[6]; birth-weights of the four types of offspring were averaged first within and then between the nine flocks for which complete data were available. Again, an enhancement effect resulted. A fifth and sixth set of unweighted data, each showing an enhancement effect, were calculated from the records of the Trawscoed Experimental Farm. Finally, an enhancement effect is apparent in human twins[7]. In all these comparisons, a small incidence of identical twins might affect relative numbers in the classes of offspring, but would not be expected to bias the average weights.

Individually, the sources of information may not show a statistically significant enhancement effect. But it is rather striking that the effect should be apparent in eight successive sets of data (one for rabbit, six for sheep, one for man). A *t* test indicated that the chance of such a regularity being due merely to sampling error was less than the conventional significance limit of one in twenty. It may also be calculated that the unweighted mean of the last column in Table 1 (+ 0·44) is significant in comparison with its standard error (± 0·152).

These eight sets of data all point towards the same conclusion; when genetically large and small offspring are born together in mixed litters, their difference in weight at birth is greater than when the offspring are born in litters of one type only. This may be ascribed provisionally to embryonic competition, in the sense that the large offspring grows unduly large at the expense of the small offspring. As may be seen in Table 1, increased weight of the male offspring contributes fairly regularly to the enhancement effect; but until more data are available, it cannot be said how regular is the contribution of decreased weight of the female offspring.

In the literature of mammalian genetics and animal breeding, there seems to be little or no recognition of an enhancement effect. If it should prove to be of general occurrence, it could have significance in several contexts. For example, in the rabbit experiment mentioned above, the estimate of superiority of one sire over another, in terms of birth-weight of offspring, varied according to the method of progeny testing; insemination with mixed semen gave a greater superiority than that obtained after the more usual type of progeny-testing with semen from one sire at a time. Enhancement is a relative term, and it might equally well be said that ordinary progeny-testing has a minimizing effect. Which test gives the correct measure of genetic superiority between the two males?

A wider possibility for multiple births in general, and not only twins, is that an enhancement effect may occur when one embryo of a litter becomes larger than a litter-mate for any reason, not necessarily genetical; for example, owing to some local uterine condition. Something like an autocatalytic process may occur; once an embryo has become large, it may have a competitive advantage and become unduly large, while growth of the smaller one will be retarded. Thus, differences in weight between embryos would become exaggerated during gestation. Studies of the origin of variation in birth-weight within the mammalian litter are liable to be biased unless this source of variation is taken into account. Moreover, further evidence from the rabbit experiment suggests that the enhancement effect measured at birth is still evident after weaning.

This work, which will be published in full, was carried out with financial support from the Agricultural Research Council. I am indebted to Prof. C. H. Waddington for interest and facilities. For access to records, I am indebted to I. L. Mason and P. Dassat, and to the Director and Staff of the National Agricultural Advisory Service Experimental Husbandry Farm, Trawscoed, Aberystwyth.

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Dominance Order for Red–Green Defective Alleles

ON the theory of Franceschetti[1,2] there are two series of multiple alleles for defective colour vision, one series responsible for deuteranopia (*D*), extreme deuteranomaly (*EDA*) and deuteranomaly (*DA*), and the other for protanopia (*P*), extreme protanomaly (*EPA*) and protanomaly (*PA*). His theory suggests that there is a dominance order for each series, such that the genes producing the lesser defects are dominant to those producing the greater, and that the two normal genes are most dominant.

This theory is supported by many pedigrees[3–7]; but it is possible to test it statistically by comparing the frequencies of defective men with those of defective women. On the theory, since the less defective genes are more dominant, and defective women are those who carry two defective genes, there should be more of the lesser defective women in proportion than of the lesser defective men.

In a group of 126 red-green defective men and women, all tested with the Rayleigh equation, in one or other form of anomaloscope test, the following frequencies were found.

	PA	*EPA*	*P*	Total
Men	15	28	20	63
Women	4	4	2	10
	DA	*EDA*	*D*	Total
Men	53	66	12	131
Women	15	7	0	22

Some of these subjects were included by chance, and others were invited as being suspected defectives, because they had made errors in daily life, or on the Ishihara or lantern tests. Since there was a special interest in defective women, more in proportion of these were invited, and there are probably three times as many as would be expected if all subjects had been found purely by chance. The fact that some subjects were invited does not affect the relative frequencies of the different types. The subjects were sometimes related; but this was not more frequent in one group than another, and does not affect relative frequencies.

Owing to the small frequencies in some of the cells it is convenient to combine the protan and deutan groups, and it is necessary to use Yates's correction. Chi-squared for the resulting table, in which we compare the relative frequencies of women with men defectives, is 9·70, and is significant on the less than 0·01 level for two degrees of freedom. It is to be inferred that there are relatively fewer *P* and *D* women than men, relatively fewer *EPA* and *EDA* and more *PA* and *DA*, as predicted by the theory being tested, which is therefore supported by the data.

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Photoperiodic Promotion of Vegetative Growth in the Cultivated Strawberry Plant

The strawberry variety Royal Sovereign is a short-day plant, flower initiation being promoted by short photoperiods, whereas stolon formation and increased petiole length are promoted by long photoperiods[1]. Hartmann[2] has shown that in short photoperiods parent plants of the variety Missionary are able to induce flower formation in attached runner plants growing in long photoperiods. This he interpreted as evidence of the transmission of a hypothetical flower-forming substance along the stolon in an acropetal direction.

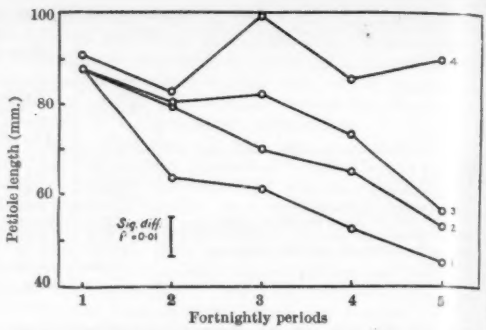

Fig. 1. Mean petiole lengths (mm.) of leaves emerging from the bud during five successive fortnightly periods

Evidence is now presented for the transmission in the opposite direction along the stolon of a substance or substances promoting stolon formation, increased petiole-length, and antagonizing the processes leading to flower formation.

Pairs of runner plants of the variety Royal Sovereign were rooted singly in pots in the field in summer. Each pair consisted of adjacent plants in a runner train. On August 11 the pairs were lifted in their pots, and the stolon, joining members of a pair, was retained intact. From this date the older of each pair of plants, described as the 'parent' plant, was grown under a 9-hr. photoperiod in the glasshouse. The attached runner plant received continuous illumination by supplementing natural light with light from incandescent lamps, initially at 15–20 ft. candles, but later increased to 30–35 ft. candles. Four defoliation treatments, with four-fold replication, were imposed. Treatments consisted of the removal of (1) all leaves, (2) all but the youngest fully expanded leaf, and (3) all but the youngest two fully expanded leaves from the runner plants. Unfolding leaves were retained in all except treatment 1. Plants of treatment 4 were not defoliated. The leaf status in treatments 1–3 was maintained by weekly removal of the oldest leaf where necessary, so that plants of treatments 1, 2 and 3 had 0–1, 1–2 and 2–3 fully expanded leaves respectively during the experiment. Parent plants were left intact. Control pairs, two in each defoliation treatment, were grown with both parent and runner plants in continuous light.

After prolonged treatment two of the four runner plants of treatment 1 (all leaves removed) initiated

Table 1. Response of Parent Plant to Long-day Treatment of Attached-Runner Plants

Treatment No.	No. of leaves retained	Mean No. of leaves formed before inflorescence initiation*		Mean No. of stolons produced	
		Parent plants in short days	Parent plants in long days (controls)	Parent plants in short days	Parent plants in long days (controls)
1	0–1	3·0 (1·86)	No infl.	0·0 (0·71)	1·5
2	1–2	5·5 (2·39)	,,	1·0 (1·14)	3·5
3	2–3	6·0 (2·55)	,,	1·5 (1·35)	4·0
4	All	12·25 (3·55)†	,,	3·75 (2·04)	4·0
Sig. diff. $P = 0·5$				(0·20)	
$P = 0·01$		(0·47)		(0·52)	

* Assuming six developing leaves in the bud.
† One plant had not initiated an inflorescence by the time the experiment was terminated. Figures in brackets are $\sqrt{n+\frac{1}{2}}$ transformations.

inflorescences, after initiating a mean number of 11·0 leaves. This alone is in support of Hartmann's experimental results with the variety Missionary. No other runner plants produced inflorescences.

The purpose of this communication is to direct attention to the results given in Table 1 and Fig. 1. The presence of leaves on runner plants in continuous light was associated with delayed inflorescence initiation, increased stolon production and increased petiole length in the parent plants growing in short photoperiods. Moreover, the effect was proportional to the number of leaves retained on the runner plants. All these responses are characteristic of the effect of long photoperiods on the strawberry.

It is suggested that the runner plants acted as donors and the parent plants as receptors of a quantitatively active stimulus promoting vegetative as opposed to reproductive growth.

The experiment was designed as a preliminary study of the influence of leaves on the runner plant in long photoperiods upon the response of the runner plant to a flower-inducing stimulus received via the stolon from the parent plant. The control layout, while adequate for the original purpose, does not preclude an explanation in terms of nutritional factors. However, the appearance of the critical parent plants, which made vigorous growth, typical of short-day responses in the variety, suggests that formative rather than nutritional factors were operating.

Further work is in progress.

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Guttridge, C. G., Ph.D. thesis, University of Reading (1953).
Hartmann, H. T., *Plant Physiol.*, **22**, 407 (1947).

Seed Vernalization and Flowering in Lettuce (*Lactuca sativa*)

TEMPERATURE, photoperiod, and chemical regulators, separately and interacting, markedly influence seed-stalk development in lettuce[1]. Conflicting reports have, however, appeared as to the effectiveness of seed vernalization in accelerating flowering in this crop[2]. In order to resolve these differences, leaf number preceding the visible inflorescence has been used as a 'physiological index' of flowering[3], and the effects of seed vernalization, in combination with temperature, day-length, and chemical regulators, have been evaluated.

A standard procedure was used for the vernalization of head lettuce seed (*Lactuca sativa*, variety Great Lakes), consisting of pre-germinating moist seed at 60–70° F. for 24–48 hr. and then subjecting to 40° F. for at least thirteen days. Periodical temperature interruptions of 60–90° F. for 2 hr. daily, or at three-day intervals, did not nullify the vernalizing effect of cold exposure. Seed which was pre-germinated for three days or more at 60° F. was not effectively vernalized by subsequent exposure to 40° F. Plants from lettuce seed which had been soaked at 60–70° F. and air-dried 6–12 hr. prior to chilling at 32° or 40° F. were delayed in flowering as compared with those vernalized according to the standard procedure. When maleic hydrazide (20 and 40 p.p.m.) was added to the water which was used in moistening the seed during vernalization, plants afterwards produced visible flower parts at a lower node than did plants from seed vernalized in water alone. (The maleic hydrazide was formulated as the water-soluble diethanolamine salt of 1,2-dihydro-3,6-pyridazinedione and applied as 'MH-40' by the U.S. Rubber Company, Naugatuck Division, Naugatuck, Conn.)

When lettuce plants were grown at night temperatures above 65° F. subsequent to seed vernalization, seed-stalk development was accelerated without preceding head formation. At temperatures below 65° F., plants grown from vernalized seed first produced a high percentage of firm, vegetative heads and then flowered. Non-vernalized plants flowered only at night temperatures above 65° F. The potential for flowering was decidedly greater following seed vernalization, but flowering was afterwards delayed by continuous night temperatures below 65° F. and was completely absent at 50° F. Much of the disparity in results obtained with seed vernalization of lettuce by various workers may be resolved on this basis.

Soil temperatures influenced the rate of seed-stalk development (days to anthesis), but not the vernalization stimulus *per se* (leaf numbers preceding the inflorescence). At the higher soil temperatures (64° and 70° F.) flowering was promoted, whereas at lower temperatures (50° and 57° F.) flowering was delayed. A decrease in the percentage of plants which produced seed-stalks occurred as soil temperatures declined from 71° to 50° F.

Likewise, photoperiod markedly affected flowering of vernalized head lettuce. The minimum night temperature following vernalization which favoured earlier flowering was reduced from 65° to 60° F. when plants were grown at a day-length of 16 hr. At 60° F. with a nine-hour day, both vernalized and non-vernalized plants formed firm vegetative heads which flowered simultaneously. Thus the flower-promoting effects of seed vernalization in lettuce may be nullified by short photoperiods as well as cool growing temperatures.

The delaying effect of cool (below 65° C.) temperatures (both soil and air) combined with relatively short days on seed-stalk development in greenhouse studies was verified in the field. Plants grown in the early spring, when night temperatures were less than 60° F., formed heads and remained vegetative irrespective of prior seed vernalization or treatment with chemical growth regulators.

This communication is based on a thesis submitted by one of us (L. R.) in partial fulfilment of the requirements for the Ph.D., Michigan State University.

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FORTHCOMING EVENTS

Monday, July 9—Saturday, July 14

Society of Chemical Industry (at the Imperial Institute, Exhibition Road, London, S.W.7)—75th Annual Meeting.

Thursday, July 12—Saturday, July 14

Institute of Physics, Non-Destructive Testing Group (at the H. H. Wills Physical Laboratory, Bristol)—Meeting on "Physics of Some New Aspects of Non-Destructive Testing".

Friday, July 13

Biochemical Society (in the Department of Biochemistry, The University, Leeds), at 11 a.m.—Symposium on "Metals and Enzyme Activity".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer, Grade B (graduate, preferably with teaching experience), in the Mathematics Department—The Registrar, Technical College, Sunderland (July 13).

Lecturer or Assistant Lecturer (with qualifications in physical or inorganic chemistry, and preferably with experience in radiochemistry) in Chemistry—The Registrar, The University, Hull (July 16).

Lecturer (preferably with special interests in entomology, physiology or protozoology) in Zoology at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 16).

Research Assistant (honours graduate in botany) at the Department of Agriculture's Cereal Station at Ballincurra, Midleton, Co. Cork, Ireland—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (July 17).

Assistant Lecturer in the Department of Philosophy—The Registrar, The University, Manchester 13 (July 21).

Lecturer in Geology—The Head of the Department of Geology, Imperial College of Science and Technology, South Kensington, London, S.W.7 (July 21).

Fellows (men or women graduates of any university) in Carbohydrate Chemistry—The Principal, Royal Holloway College, Englefield Green, Surrey (July 23).

Lecturer (with training or experience in one of the following fields: (*a*) hydraulics; (*b*) aerodynamics; or (*c*) hydrodynamics) in the Department of Fluid Mechanics—The Registrar, The University, Liverpool (July 23).

Lecturer/Senior Lecturer in Electrical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 27).

Lecturer in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (July 28).

Soil Microbiologist (with a good honours degree and practical experience)—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, Sussex (July 29).

Assistant (graduate in medicine, biology, psychology, sociology, or any other social science) in the Department of Public Health and Social Medicine—The Secretary, The University, Edinburgh, (July 31).

Assistant Lecturer (with special qualifications or interests in radio astronomy) in Physics—The Registrar, The University, Manchester 13 (July 31).

Lecturer in Anatomy—The Registrar, The University, Manchester 13 (August 7).

Lecturer in Education, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 15).

Lecturer in the Department of Botany, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 15).

Chair of Electrical Engineering at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Lecturer in the Department of Zoology, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, September 1).

Assistant Chemist (with a degree in chemistry, agricultural chemistry or A.R.I.C., or about to qualify) for analytical work on crops and soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. 1052/7.

Assistant Experimental Officer (male, with G.C.E. advanced level in science subjects, including mathematics and chemistry, or equivalent qualifications) in the Analytical Section, Medical Division, for work involving the analysis of radioactive and other toxic agents in biological specimens and in air—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 541/34.

Assistant Professor in the Department of Anatomy—Prof. R. L. de C. H. Saunders, Dalhousie University, Halifax, Nova Scotia, Canada.

Biochemist (with a first- or second-class honours degree in biochemistry or equivalent qualification, with postgraduate research experience), to study the chemical properties of cervical mucus in relation to the action of sex hormones—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/3.

Biochemist (with Ph.D., M.Sc., or equivalent qualification) to engage in research on the biosynthesis of proteins—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

Chemistry Master, to teach to advanced level—The Headmaster, The Hall, Repton, Derbyshire.

Head of the Chemistry Department—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Manchester 20.

Lecturer (with an honours degree in metallurgy and preferably with industrial and research experience) in Metallurgy—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

Principal Lecturer (with research experience, and preferably industrial experience) in Ceramic Materials in the Department of Metallurgy—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow, C.1.

Research Assistant (with Inter. B.Sc. or equivalent qualification in chemistry or metallurgy) to assist in the general work of the Corrosion Section of the Chemistry Department, and in particular to assist in research on rust resisting steels for aircraft—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "C.R.1".

Senior Lecturer in Inorganic Chemistry; and an Assistant Lecturer, Grade B, in the Physics Department—The Acting Principal, Royal Technical College, Salford 5.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research. Food Investigation Special Report No. 62: Dehydration of Fish—British Experiments (1939–54) and the Development of a Warm Air Drying Process. By Dr. C. L. Cutting, Dr. C. A. Reay, and Dr. J. M. Shewan. Pp. iii+160+8 plates. (London: H.M. Stationery Office, 1956) 7*s*. 6*d*. net. [2

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